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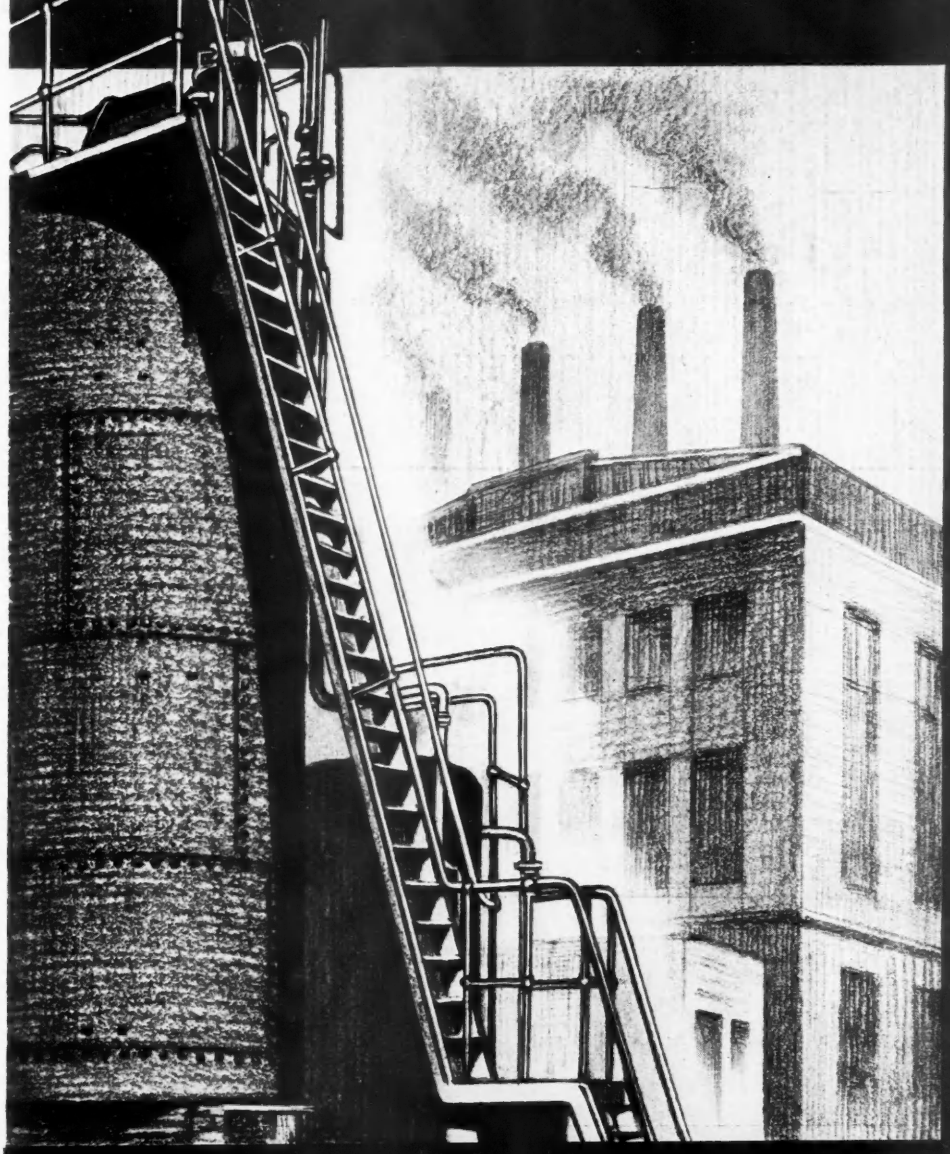

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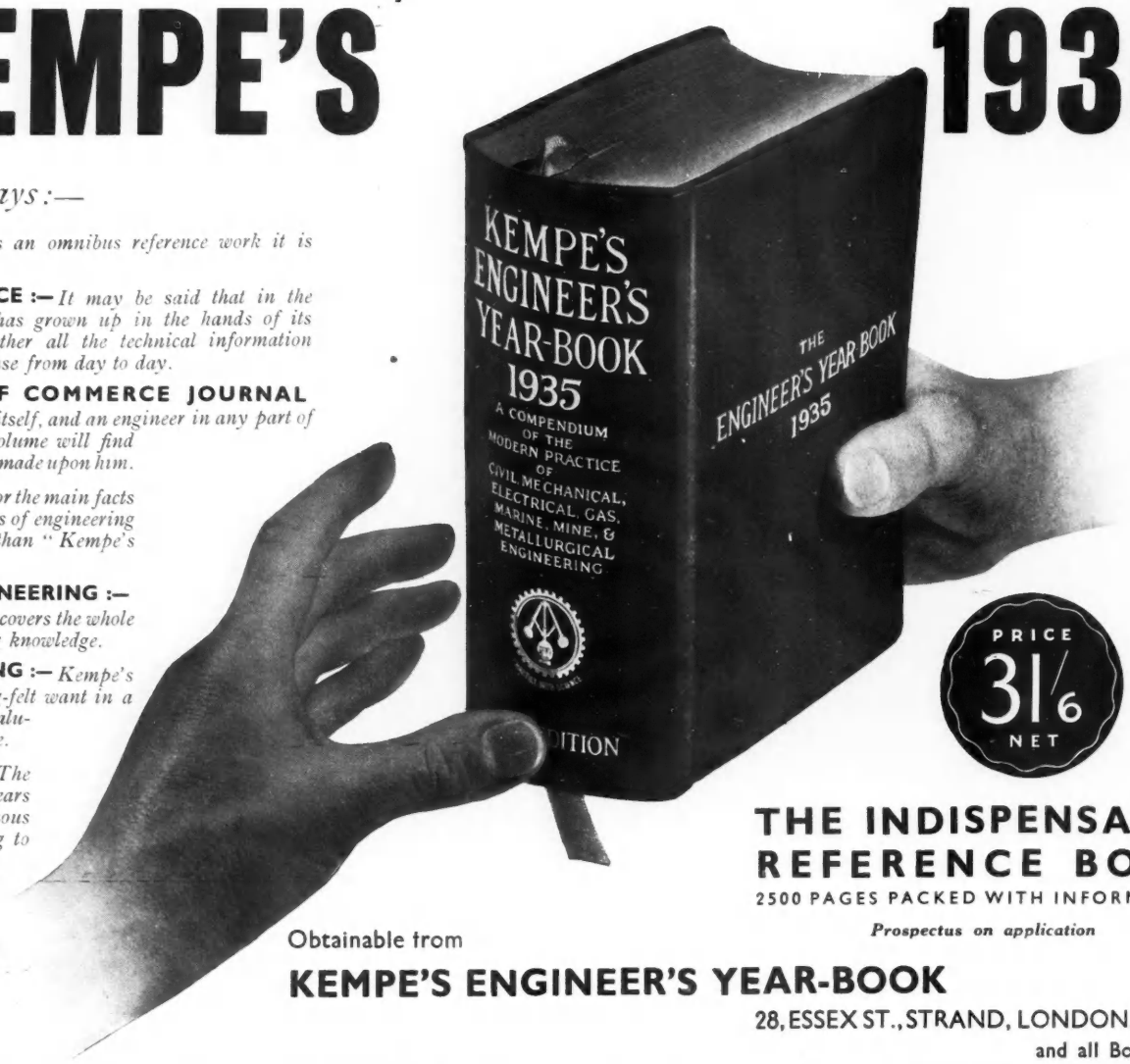
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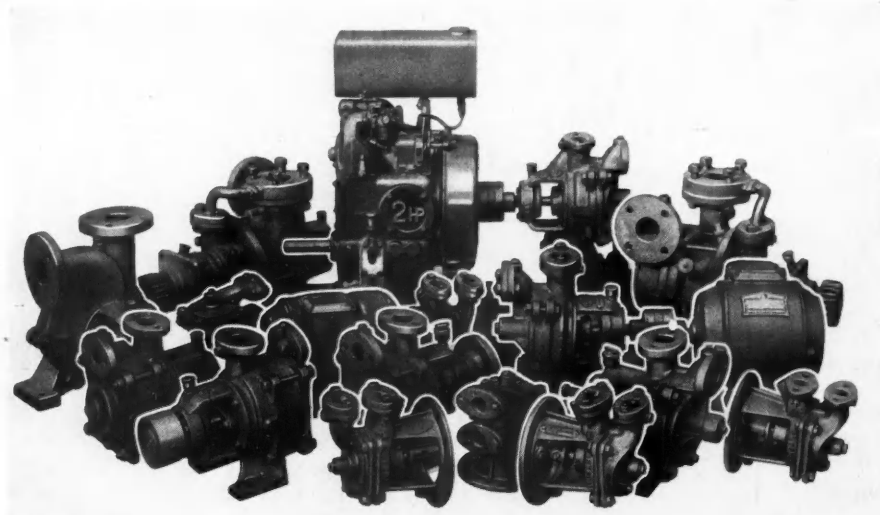

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A Seven-Day Journal

State Scientific Services.

IN his presidential address at the annual general meeting of the Institution of Professional Civil Servants last week, Sir Richard Redmayne referred to the reorganisation of State scientific services which is now taking place as a result of the Treasury's decision to implement the recommendations made by the Carpenter Committee in 1930. He stated that the Institution's satisfaction at this decision was qualified by the facts that the War Office had apparently taken no steps to apply the Committee's recommendations to its scientific staffs and that the remuneration of the higher posts in the scientific departments had not been dealt with, although the present standards had been rendered obsolete by the improvements conceded to the grades immediately beneath them. He also expressed dissatisfaction that, although the present reorganisation represented some mitigation of the underpayment of scientists, no attempt had been made to examine the functions and organisation of scientific establishments. Sir Richard Redmayne considered that one of the most significant events of the past year, from the point of view of a more efficient Civil Service, were the decisions on the application to the Post Office of the findings of the Bridgeman Committee. He referred to the definite break with tradition which had been made in the Post Office by replacing the secretariat by a functional board, and pointed out that the Institution in its evidence before the Royal Commission on the Civil Service had advocated the introduction of the board system in Civil Service departments which should have the effect of enabling the heads of technical departments to bring technical considerations effectively to the notice of the ultimate authority whenever decisions on policy had to be taken. The Institution felt strongly that no proper consideration had yet been given to the important question of the sphere of the technical expert in the public service.

Jubilee Exhibition at the Science Museum.

To mark the occasion of His Majesty's Silver Jubilee, a pictorial exhibit illustrating the more outstanding inventions and conspicuous developments of the past twenty-five years has been arranged at the Science Museum. The exhibition was opened on Wednesday, May 1st, and will remain open during the whole of the month. The display has been arranged to portray the most important achievements of scientific research and invention, and to recall, by means of photographs, the striking progress which has been made during that period in all branches of science and technology. The main advances in the pure sciences—astronomy, mathematics, physics, chemistry, meteorology, and geophysics—are illustrated, together with their more important applications. These include modern methods of upper air investigations, radio-gramophones, "talking pictures" equipment, infra-red photography, and modern methods of prospecting. Of special interest is the series of photographs showing the rapid advances which have recently been made in our knowledge of the constitution of the atom, and the structure of the atomic nucleus. Progress of chemical industry is shown to include many important developments, such as the low-temperature carbonisation of coal, the manufacture of insulin, artificial silk, and plastic products; while in the case of glass manufacture, reference is made to the improvements resulting from the introduction of machine processes and the influence on the glass industry of the widespread use of the motor car. Among other subjects may be mentioned the development of aircraft, ships, locomotives, motor vehicles, steam turbines, and oil marine engines. The advances in electrical power and communication are illustrated by modern electric power stations, automatic telephones, radio-communication, and television. The Science Museum at South Kensington is open free on weekdays from 10 a.m. to 6 p.m., and on Sundays from 2.30 to 6 p.m., and public lectures are given twice daily by guide lecturers.

Noise in Industry.

A VALUABLE report published on May 7th by the Industrial Health Research Board of the Medical Research Council (formerly the Industrial Fatigue Research Board), which discusses the performance of weavers under varying conditions of noise, was recently completed by Mr. H. C. Weston and Mr. S. Adams. It covers a period of twelve months and two groups of ten weavers were employed, one of the groups being used as a control, while each member of the other group wore ear defenders throughout the hours of the experimental period. The present report agrees well with a former investigation and shows that the effect of the noise which is normally associated with weaving, and has an intensity of about 96 decibels, is to lower the rate of output by about 3 per cent. of that obtainable when the noise intensity is reduced to a level of 81 decibels. In terms of personal efficiency this is equivalent to an increase of about 7½ per cent. with subdued noise. The actual reduction of noise intensity effected in the experiments described was 15 decibels, and, within the range of intensities considered, this probably represented about a 50 per cent. reduction of the apparent loudness. In a purely manual process the 7½ per cent. increase of personal efficiency would, the authors state, probably have resulted in a 7½ per cent. increase in output, an effect of considerable magnitude. The experiments described go to show that an adequate reduction of noise can be simply effected by a convenient form of ear plug, which, if properly designed and fitted, should cause no discomfort to the wearer. They further strengthen the conclusion that excessive noise is by no means a negligible factor in determining industrial efficiency.

The Royal Aeronautical Society.

MANY engineers were among those numbering over 1100 who attended the garden party of the Royal Aeronautical Society, which took place at the Fairey Aviation Company's Great West Aerodrome, near Hayes, on Sunday last, May 5th. The guests were received by the President, Lieut.-Colonel J. T. C. Moore-Brabazon and the Council. During the afternoon there was a varied flying programme, which included the arrival from Reading of Mr. Collins, of the London Gliding Club, in his glider. When the towing machine was at a height of some 2000ft. near Reading, the tow line parted, but by clever controlling the aviator reached a height of 4000ft., and arrived in good time at Hayes. Mr. Thom, of A. V. Roe and Co., Ltd., gave an exhibition of aerobatics, while in the hangar the Royal Aeronautical Society showed a selection of photographs lent by various firms which illustrated the development which has taken place during the last twenty-five years in aircraft and accessories. Mr. J. E. Hodgson, the honorary librarian of the Society, also showed a collection of historical prints. A programme of music was given by the Central Band of H.M. Royal Air Force.

The L.M.S. Railway "Silver Jubilee" Exhibition.

ON Thursday, May 2nd, we were present at the special view of an exhibition, staged by the London, Midland and Scottish Railway at Euston Station, to demonstrate the advance in locomotive and rolling stock design during the past twenty-five years of the King's reign. Engine "No. 5552," named "Silver Jubilee," and the first of thirty similar 4–6–0 three-cylinder express locomotives to be built during the coming year, was the central feature of the exhibition. In honour of the occasion, this engine has been finished in shining black and most of its fittings have been chromium plated, giving it a distinctive and dignified appearance, well in keeping with its name. It heads a train made up of the company's latest types of rolling stock, comprising a corridor third-class brake car, corridor first-class luxury car, composite vestibule car, first-class dining car with a kitchen, vestibule first-class, and a vestibule third-class brake car. As a contrast to the "Silver Jubilee" train, at the next platform is the 4–4–0 locomotive "No. 5348," "Coronation," built at Crewe works in 1911, heading a train of carriages which were built in the same year, and have been brought together from various sections of the railway. This train comprises a corridor third-class brake carriage, third-class corridor carriage, composite dining car with kitchen, corridor first-class carriage, corridor composite carriage, and a corridor composite brake carriage. The locomotive "Coronation," in full working order, weighs 99 tons and has a tractive effort of 20,066 lb., whilst the "Silver Jubilee" weighs 134 tons and has a tractive effort of 26,610 lb. A comparison between the two trains emphasises the progress of locomotive practice in twenty-five years, both in design and efficiency. What is probably more striking from the travellers' point of view is the high standard of luxury which has been attained in the modern railway coach.

The Kelvin Medal.

AT the Institution of Civil Engineers, on Tuesday, May 7th, Sir John Ambrose Fleming was presented with the Kelvin Medal, which is awarded triennially as a mark of distinction in engineering work or investigations of the kind with which the late Lord Kelvin was specially identified. In making the presentation, Sir Kingsley Wood, the Postmaster-General, said that it was a remarkable fact that, in spite of the small area of these islands, Great Britain had always been in the forefront in the possession of men of the very highest scientific ability and originality. This country had led the way in the application of science to industry, and it depended on the output of the universities for the inception of new scientific methods and scientific knowledge. It was in that category, therefore, that it was so much indebted to Sir Ambrose Fleming, not only for his own contributions to research and the application of research to industry, but also for the inspiration which he had given to several generations of students. Sir Kingsley Wood went on to say that he understood that America spent more upon research than did this country. It was true that mass production in research might well produce results, but it did so at a relatively higher cost than the research of inspired and gifted individuals. Our nation must ever encourage those whose natural genius lay in the direction of the advancement and application of scientific knowledge. It was not the cost, but the quality of the research which counted. Sir Ambrose Fleming, in reply, said that he had a deep sense of the great distinction conferred by the presentation of the medal. His pleasure was increased by the recollection that for more than twenty-five years he enjoyed the acquaintance and friendship of Lord Kelvin.

American Aircraft Operating Costs.

SOME figures given in the American Interstate Commerce Commission Report reveal that except on certain favoured routes there is very little difference in the average speeds of American air liners when compared with similar British aircraft. The American lines are in possession of one or two outstanding types of machine, as, for example, the "Douglas," which, although it has now been surpassed in speed, is still a noteworthy machine numerously represented on important American routes. Great Britain has no equivalent type to the "Douglas," as British operators consider that a bigger capacity is required on the main routes, while a smaller type is adequate for "feeder" and internal British routes. In the main, the flying boat is a class in which the British air lines and the R.A.F. excel, although, again, the few machines of the latest American type show a slight gain. The following figures quoted in the report relate to the leading American lines:—American Air Lines Incorporated: Average fleet cruising speed, 137 m.p.h.; average pay load per machine, 2348 lb.; average machine horse-power, 902. North American Aviation Inc.: Average speed, 126 m.p.h.; average pay load, 2185 lb.; average horse-power, 807. Pan American Airways: Average speed, 108 m.p.h.; pay load, 2959 lb.; horse-power, 1041. Transcontinental and Western: Average speed, 149 m.p.h.; pay load, 3186 lb.; horse-power, 1122. Western Air Express: Average speed, 121 m.p.h.; pay load, 2420 lb.; horse-power, 1120. United Air Lines: Average speed, 127 m.p.h.; average pay load, 1799 lb.; average horse-power, 759.

Oil from Coal.

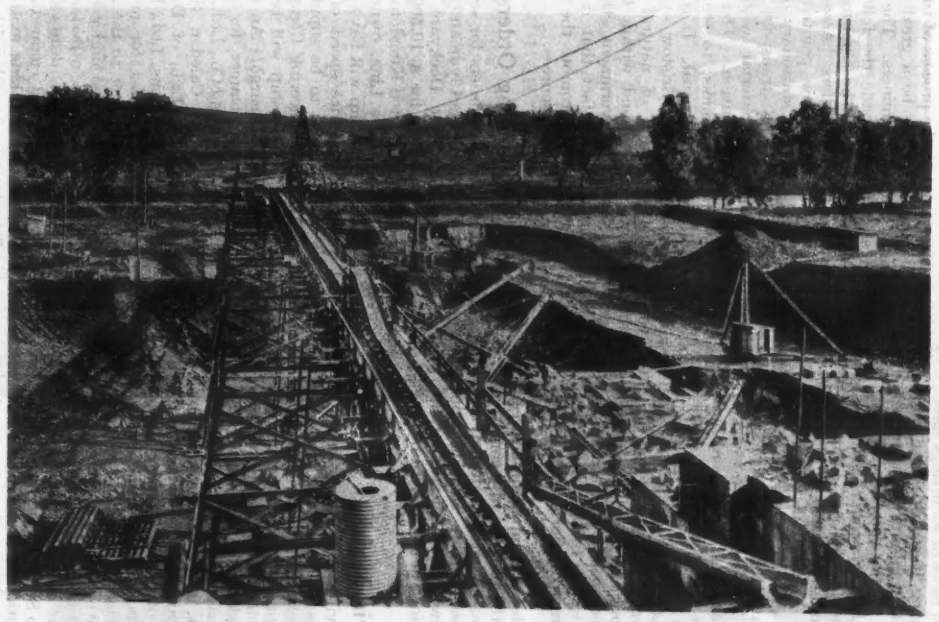
ON Wednesday, May 1st, in the House of Commons, the resolution increasing the duty on heavy fuel oils used for road transport from 1d. to 8d. per gallon was agreed to. Features of the discussion were the Chancellor of the Exchequer's defence of the duty on the grounds of revenue, and the defeat of an amendment to halve the proposed increase of 7d. and make the duty 4½d. Colonel Moore-Brabazon said that it should not be forgotten that the tax was a Customs duty and not an Excise one. It was, in his opinion, a direct encouragement to the process of turning coal into oil, and might therefore be a great benefit to the coal industry and to the miners. The same idea is stressed in a statement made the following day by Colonel W. A. Bristow, the Chairman of the Low-Temperature Coal Distillers' Association of Great Britain. Colonel Bristow pointed out that aviation petrol and fuels for stationary oil engines, and engines for road and rail transport can all be produced from indigenous material by the process of low-temperature carbonisation. The new tax, therefore, cannot fail, he thinks, to stimulate the production of oil from British coal. It is somewhat disquieting to reflect, Colonel Bristow says, that of the total world production of natural petroleum less than 1 per cent. is found within the British Empire. The National Government, therefore, is to be congratulated on the fact that it has again demonstrated the desire to promote the production of liquid fuels from our own resources.

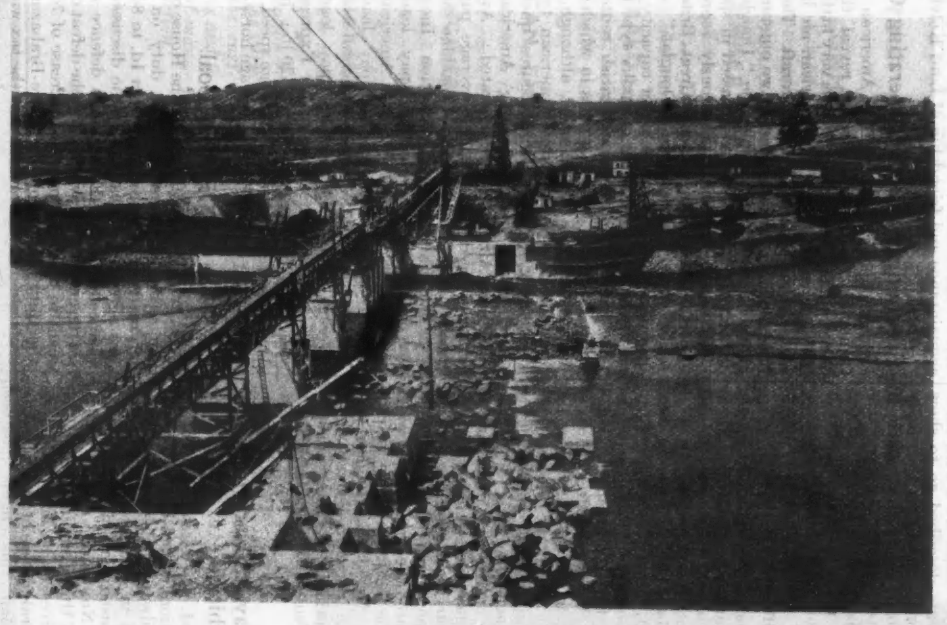
New Shipbuilding Orders.

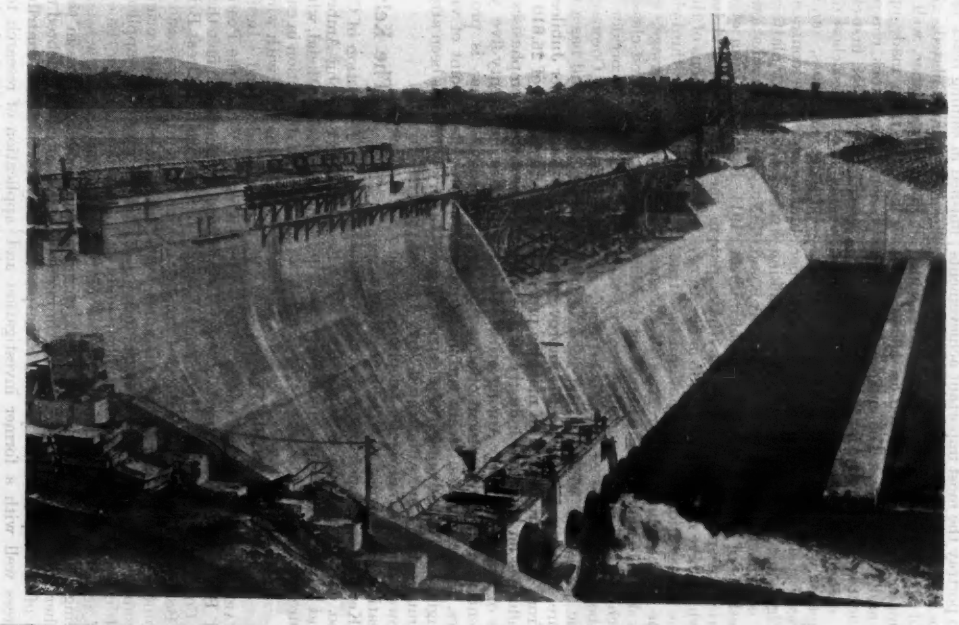
DURING the last few days orders for several more ships have been placed on the Clyde and the North-East Coast. The Greenock Dockyard Company, Ltd., has received an order for a 10,500-ton deadweight cargo liner for the United Kingdom-Australian service of the Scottish Shire Line, owned by Clan Line Steamers, Ltd. The ship will have a length of 470ft., and a designed service speed of 16 knots. The propelling machinery is to be supplied by the North-Eastern Marine Engineering Company, Ltd., of Wallsend-on-Tyne. The ship will be fitted for the carriage of refrigerated cargo. An order for a 14-knot, 218ft. passenger steamer for the Indian coastal trade of Hall Angier and Co., Ltd., of London, has been placed with the Caledon Shipbuilding and Engineering Company, Ltd., of Dundee. Sir William Reardon Smith and Sons, Ltd., have placed orders on the North-East Coast for new tonnage, a proportion of which is subject to the approval of the Scrap and Build Committee under the Government scheme. Sir Arthur M. Sutherland has also ordered two further 9000-ton deadweight motor vessels which will be built and engined by William Doxford and Sons, Ltd. Speaking in the House of Commons on Tuesday evening, May 7th, Mr. Walter Runciman, the President of the Board of Trade, stated that so far applications for assistance have been received from eleven shipowners. These cover proposals to build ten vessels aggregating 48,000 tons gross, and ten smaller vessels aggregating 8000 tons gross. It seems, therefore, likely that further orders will be placed in the near future.

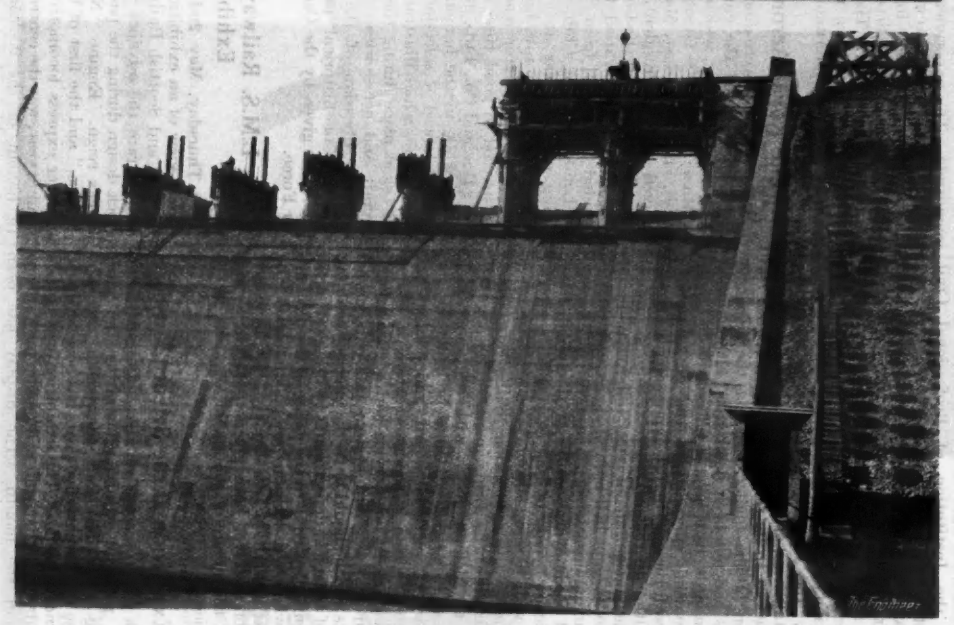
CONSTRUCTION OF THE HUME DAM, MURRAY RIVER, AUSTRALIA

(For description see opposite page.)









ABOVE:—CONVEYOR FOR PLACING CONCRETE ON MAIN DAM
BELOW:—VIEW OF DAM FROM NEW SOUTH WALES SIDE

ABOVE:—CONSTRUCTION OF MAIN DAM
BELOW:—THE SPILLWAY SECTION

The Hume Dam on the Murray River.*

THE river Murray in Australia rises in the northern slopes of the Australian Alps and, flowing in a westerly direction, forms for a large part of its course the boundary between the states of New South Wales and Victoria. After crossing the border into South Australia, it makes a sharp turn towards the south, and finally reaches the sea at Encounter Bay. At various parts of its course its waters and those of its tributaries are used for irrigation purposes. In the period immediately following the war there was a considerable extension, particularly on the Victoria side, of the areas so served by the river, and by 1933, after a considerable number of control works had been constructed, the extent of irrigation in that state was, according to a report of the State Rivers and Water Supply Commission, 170,675 acres. Of this area, over one-half consisted of pastures, natural and sown, and the remainder of fodder crops, vineyards, orchards and the like. Owing largely to the fact that until the Hume dam is completed, the supply of water is insufficient, only about 9000 acres in New South Wales have so far been irrigated.

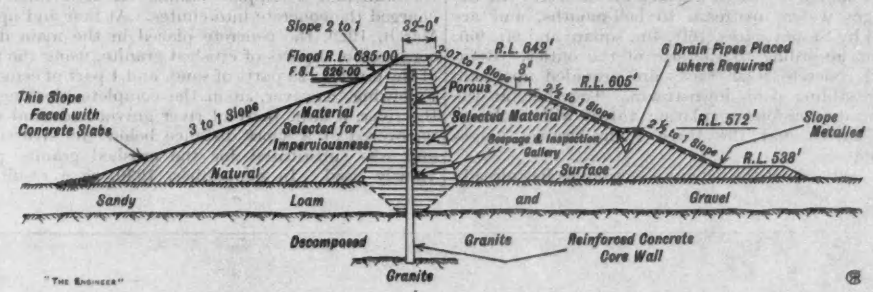
The various projects for the improvement of the Murray River, many of which are now being carried out, date back to a time some years before the war. But it was not until January 31st, 1917, that the River Murray Waters Act came into force. That Act formed an agreement between the Commonwealth and the states of New South Wales, Victoria, and South Australia as to the uses to which the waters should be put, and the proportion in which the expense of constructing the various works should be borne. It provided for the construction of a number of weirs and locks, and for the erection of works which would enable Lake Victoria, in New South Wales, not far from the South Australian border, to be used as a storage reservoir. In addition, it also provided for the construction of a dam—the Hume dam—far up the course of the river in the neighbourhood of Albury which would impound 1,100,000 acre-feet. By June of last year the Lake Victoria storage works and a number of the weirs and locks had been completed, while the Hume dam was approaching completion. On the completion of this latter dam, it will be possible largely to increase the area under irrigation, particularly in New South Wales. There is an area on that side amounting to about 5,000,000 acres, which could be fed by gravitation with water from the river, but the quantity available will only be sufficient for a small proportion of this vast area. Works are now in progress for the irrigation of 536,759 acres of this area, and proposals for the creation of a second district of 605,000 acres have been put forward.

The Hume Dam.

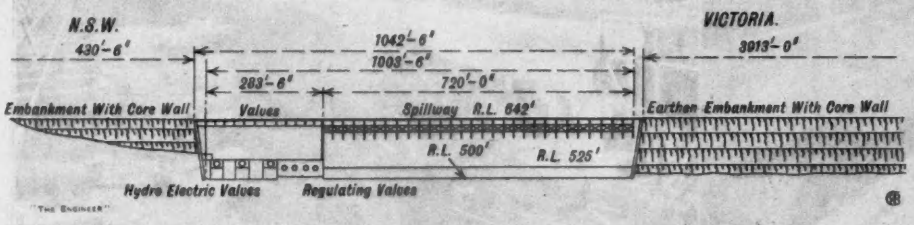
The site finally chosen for the Hume dam, after testing the conditions in twenty-five alternative places, lies about half a mile below the junction of the Mitta-Mitta River with the Murray, and a few miles upstream of Albury. At this point a suitable granite foundation for the dam has been found at a reasonable depth below the surface. The catchment area above the dam amounts to about 6000 square miles. As soon as the site of the dam had been chosen, estimates were made of the annual discharge which it was likely would be available. According to observations made at Albury, the maximum flow recorded, occurring in 1917, was 10,586,254 acre-feet, and the minimum, in 1902, 895,810 acre-feet. Taken over forty-eight years from 1885 to 1932 the average flow was estimated at 3,764,000 acre-feet annually. These figures refer to a point some distance below the dam, and include a contribution from the Kiewa River which joins the Murray between the site of the dam and Albury. Deducting the estimated annual flow of the Kiewa, that at the dam worked out at about 3,244,000 acre-feet per year. In a report issued early in 1924, the members of the River Murray Commission stated that after a review of all the facts put before them they held the opinion that a regulated flow of 263,000 acre-feet per month for nine months in each year was the maximum that could be relied upon from the catchment with a reservoir of any capacity.

The original design of the Hume dam provided for the creation of a reservoir with a capacity of 1,100,000 acre-feet, but as the years passed the figure for storage capacity was several times amended. At present the dam is being built for a capacity of 1,250,000 acre-feet, and is so designed that at a later date the capacity can be increased to 2,000,000 acre-feet. On the assumption that during the three months—May, June, and July—when no irrigation water is required, the flow of the Kiewa and other tributaries will meet the requirements of the river without addition from the reservoir, it has been estimated that at a monthly flow of 263,000 acre-feet during the remaining nine months, a reservoir of 1,250,000 acre-feet capacity would have failed in the exceptional drought periods of 1902–03 and 1914–15, and again during the month of April, 1930. Actually, of course, should the storage behind the dam as built fall below a reasonable level in the future, the quantities released will be reduced.

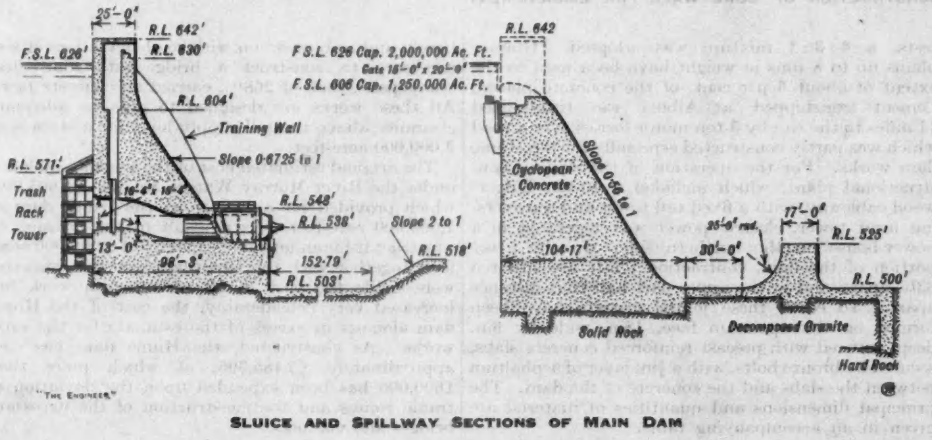
As will be seen from the engravings, the dam now approaching completion, consists of a central section, built of concrete, 1042ft. 6in. in length, with embankments on either side, 430ft. 6in. and 3913ft. in length respectively. For a length of 720ft. the concrete structure has been built as a spillway and the remainder of this section contains the regulating valves and three outlets for a projected hydro-electric development. The spillway has been designed to deal with a maximum discharge of 182,000 cusecs. Actually, according to estimates made as a result of gauging the 1917 flood at Corowa, the discharge at the site of the dam in that year was only 90,000 cusecs, but in view of the fact that a totally abnormal flood in the Murrumbidgee River overtopped the Burrinjuck dam in 1925, it was decided to give the Hume dam ample capacity for the discharge of flood waters. The spillway section which can be seen under construction in engravings on page 480 has a vertical upstream face and a downstream face curved to conform to the flow of the overfalling water. Its lip is 15ft. below the full supply level of the 2,000,000 acre-feet storage, and eventually twenty-nine steel vertical lift gates, each 20ft. long by 15ft. high, will be provided to raise the water level. The dam is designed to withstand a surcharge of 9ft. over the top of the gates, which will be lowered as soon as the flood waters rise above full supply level. It is estimated that at the foot of the wall the overfalling water will attain a velocity of about 90ft. a second, and an energy dissipator in the form of a trough, 80ft. wide and 25ft. deep, has been built at the downstream foot. The mean velocity on the downstream apron will be reduced by this means to 6·3ft. per second. On the New South Wales side, the concrete dam has been



SECTION THROUGH EMBANKMENT



ELEVATION OF HUME DAM



SLUICE AND SPILLWAY SECTIONS OF MAIN DAM

EMBANKMENT ON VICTORIA SIDE

* This article is based upon a paper by H. H. Dare entitled "The River Murray Waters' Scheme," Proc., Inst. Mech. E., Australia, 1934.

built for a length of 283ft. 6in. to the full height necessary for a storage of 2,000,000 acre-feet. In this, the sluice section, seven outlets are arranged. The three at the landward end are intended eventually to serve for hydro-electric purposes, and the passages are 13ft. in diameter at the circular section. For the time being, needle disperser valves, 7ft. 6in. in diameter, have been fitted to these passages. The remaining four outlets are designed as sluices, and are 9ft. in diameter at the circular section and fitted with needle disperser valves similar to those already mentioned. All the passages widen upstream to bell-mouths, and are closed by Stoney gates, 16ft. 4in. square and 9ft. 9in. square, according to the size of the outlet. Reinforced concrete trash racks are provided upstream and a stilling pool downstream. Together, at the full head, the four regulating valves will discharge 8600 cusecs and the three hydro-electric valves 5940 cusecs.

On each side of the concrete section, as has already been mentioned, the dam is continued as an embankment, with a reinforced concrete core wall, a section through which is reproduced on page 481. The upstream slope is protected by concrete slabs, 6ft. 6in. by 12in. thick, laid on 6in. of gravel and abutting against a toe consisting of large hand-placed stones. The material for the embankment was obtained from excavations near the site, and consists mainly of clay overlying decomposed granite. This material was excavated by 3 cubic yard shovels and loaded into side dump trucks, which were transported by locomotives and dumped their loads where required. The material was spread by ½ cubic yard wheeled scoops drawn by horses. On the upstream side clayey material alone was used, but on the downstream side a certain amount of stoney material was mixed with the clay. The core wall, the design of which is well seen in one of the tone engravings, was carried down a maximum of 87ft. below the natural surface to bed at least 5ft. into solid rock. A considerable amount of pumping and timbering was necessary in carrying out this work. The wall is constructed with contraction joints, 30ft. apart, and varies in thickness from 2ft. near the top to about 6ft. near the base. Two rows of reinforcement are embedded in the concrete. On the downstream face of the wall and supported at intervals of 15ft. by buttresses there is a semi-circular inspection tunnel, 6ft. 6in. in height. Drainage water can enter the tunnel through weep holes at the top, bottom, and centre, and, the tunnel being laid on a gradient, will be discharged at the end of the spillway section of the main dam.

For the construction of the main concrete dam, the river was dealt with in two stages. During the first stage levee banks were built on the flat on the northern side of the river to a height of 3ft. above maximum flood level, and tied into the hill slopes up and downstream, stone beaching being provided along the river face. The effect of constricting the channel was to cause the river to rise to a higher level than that of the record flood, but the area protected by the levee was free from water, and within this area were constructed the sluice section and part of the spillway section. During the second stage, an area of 12½ acres, including the river channel, was surrounded by a cofferdam, consisting of an outer face of sheet steel piling, 40ft. long, driven to decomposed rock and an inner skin of timber piles and sheeting forming a space 20ft. wide, which was filled with sand. By the use of one 4in. pump, the cofferdam was kept dry. In order to provide for the passage of flood waters during construction, a portion of the wall was kept at a lower level, while during the period when work was proceeding inside the cofferdam, a space of 1000ft. was left between the Victorian embankment and the southern wall of the cofferdam to allow of flood waters passing over the river flat at that end. Excavations for the foundations were carried 3ft. into solid granite from the upstream face of the wall to the downstream end of the cut-off and to the surface of the solid granite for the remainder on the downstream side of the cut-off. Concrete was mixed in two 2 cubic yard mixers, and placed by the help of the rubber conveyor belt, 32in. wide, to be seen in some of the engravings. This belt was carried by a timber trestle on the upstream side of the wall and a tripper running on light rails discharged the concrete into chutes. At first and up to March, 1929, the concrete placed in the main dam consisted of 5 parts of crushed granite, using the run of the crusher, 2½ parts of sand, and 1 part of cement. Following, however, upon the complete blocking of the river, a large body of river gravel and sand was uncovered at a short distance below the structure, and was substituted for the crushed granite previously used. In September, 1930, as a result of tests, a 6 : 3 : 1 mixture was adopted. Granite plums up to 8 tons in weight have been used to the extent of about 6 per cent. of the concrete placed. Cement transhipped at Albury was transported 11 miles to the site by 5-ton motor lorries over a road which was partly constructed especially for the Hume dam works. For the operation of the various constructional plant, which included a 10-ton Lidgerwood cableway, with a fixed tail tower and a traversing head tower, electric power was generated in a power-house on the northern side. In the lower portion of the dam, contraction joints are situated 83ft. apart, and in the upper part half that distance apart. To cover these joints, grooves have been formed on the upstream face, 18in. wide by 6in. deep, covered with precast reinforced concrete slabs, secured by bronze bolts, with a ¾in. layer of asphaltum between the slabs and the concrete of the dam. The principal dimensions and quantities of material are given in an accompanying table.

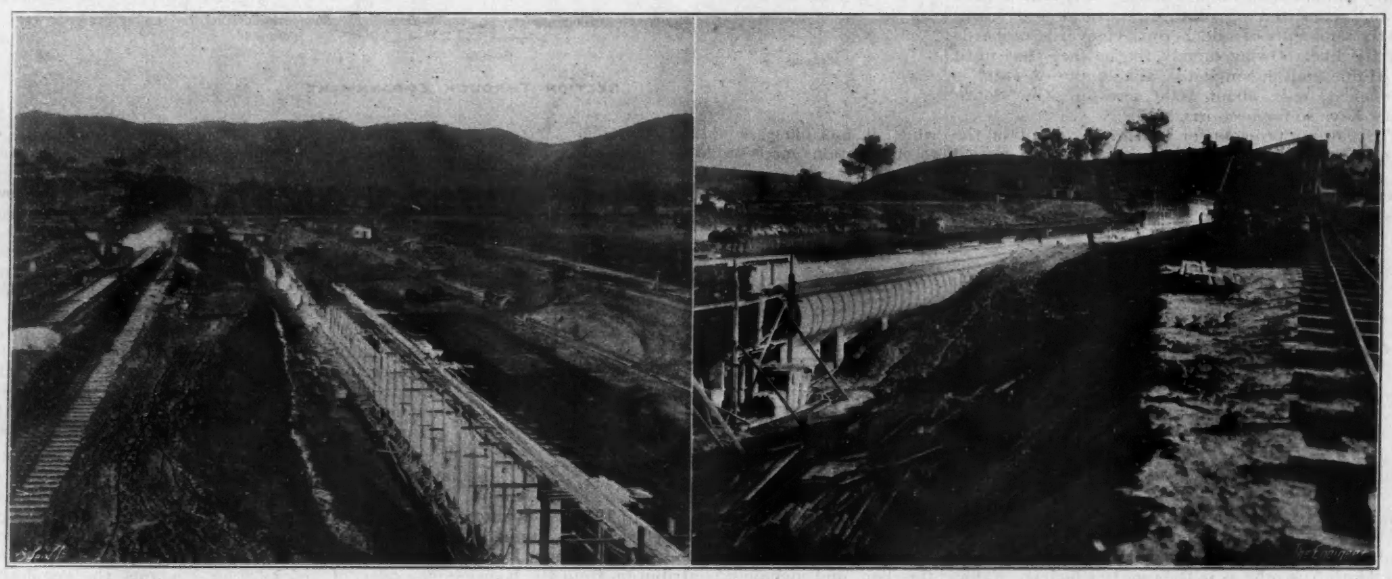
As a result of the creation of the reservoir, it has been necessary to make road and rail diversions.

Particulars of Hume Dam.

Catchment area	6,000 sq. miles	
Capacity, acre-feet	1,250,000	2,000,000
Full supply level	R.L. 606	R.L. 626
Area at F.S.L., acres	33,000	44,000
Maximum depth of water	106ft.	126ft.
Length of reservoir :		
Murray River	39 miles	50 miles
Mitta Valley	21 miles	25 miles
Length of earth bank, N.S.W.	430ft. 6in.	
Length of concrete wall, N.S.W.	1,042ft. 6in.	
Length of earth bank, Victoria	3,815ft.	
Total length	5,288ft.	
Estimated quantity of concrete in dam as constructed :		
N.S.W.	431,528 cu. yd.	
Victoria	110,440 ,,	
Estimated quantity of concrete in subsidiary bank, Victoria	6,689 ,,	
Total concrete	548,657 ,,	
Estimated quantity of earthwork	4,162,860 ,,	

The deviation of the railway to Tallangatta necessitated the construction of a viaduct over Sandy Creek, and in connection with road deviations it was necessary to construct a bridge with nine steel truss spans, each of 268ft., carried on concrete piers. All these works are designed to give an adequate clearance above the full supply level for a storage of 2,000,000 acre-feet.

The original estimated cost of the schemes included under the River Murray Waters Act was £4,663,000, which provided for a storage at the Hume dam of 1,000,000 acre-feet. As a result of the decision to construct it for an ultimate capacity of 2,000,000 acre-feet, together with the fact that since the estimates were made the cost of all construction work has increased very considerably, the cost of the Hume dam alone is in excess of the estimate for the total works. As constructed, the Hume dam has cost approximately £5,485,395, of which more than £600,000 has been expended upon the deviation of traffic routes and the construction of the necessary bridges and viaducts.



CONSTRUCTION OF CORE WALL FOR EMBANKMENT

The Iron and Steel Institute.

THE annual general meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Great George-street, London, on Wednesday, May 1st, and was completed on that day instead of extending over two days as usual. Actually, however, the meeting was carried over three days, because the following two days—May 2nd and 3rd—were devoted to a Symposium on Welding, arranged by the Institute and fifteen other engineering and allied institutions and societies.

The President inducted his successor—Sir Harold Carpenter, F.R.S.—into the chair, and in doing so reminded the members that Sir Harold was a great-great-grandson of Henry Cort, who was the originator of puddling 150 years ago.

The Bessemer Gold Medal.

The President, referring to the Bessemer Gold Medal of the Institute, said it had been awarded this year to Professor A. M. Portevin, Director of the Institut de Soudure Autogene, Professor at the Ecole Superieure de Fonderie, and at the Ecole Centrale des Arts et Manufactures, Paris. Professor Portevin, he said, obtained a Carnegie Scholarship in 1907, and the results of his investigation, which dealt with the constitution of special ternary steels, were published in the "Carnegie Scholarship Memoirs" in 1909. For that work he was awarded the Carnegie Gold Medal. Professor Portevin was elected a member of the Institute in 1910.

Up to the present, said the President, there had been sixty-seven awards of the Bessemer Medal, and twenty-five of them had been made to distinguished foreign metallurgists.

Professor Portevin, who received a very cordial reception, speaking in French, said that in 1909 the late Sir Hugh Bell had presented him with the Carnegie Gold Medal which had been not only a source of profound satisfaction to him, but a valued encouragement to pursue his researches in metallurgical science. After expressing his appreciation of the presence at the meeting of his Excellency le Viscomte de Halgouet, the representative of the French Ambassador, Professor Portevin thanked the Council and members of the Institute for the distinction which had been conferred upon him and recalled several of those whose advice and support had been so

valuable to him at the commencement of his career.

PRESIDENTIAL ADDRESS.

The President then delivered his address, which is reprinted in an abridged form on pages 492–494.

CORROSION.

The Third Report of the Corrosion Committee was next presented by Dr. Hatfield. Since it forms a volume of 214 pages, abstraction is impracticable, but our readers will be able to gain some idea of the contents from the following summary index :—

The Report is in five sections :

Section A deals with the constitution of the Committee and the present position of the Committee's work.

Section B describes the progress of the Committee's field tests on atmospheric corrosion.

Section C refers to marine corrosion.

Section D includes seven individual contributions by members of the Laboratory Research Sub-Committee and other investigators.

Section E deals with other matters relating to corrosion considered by the Committee.

Section B (Atmospheric Corrosion).—The progress of the Committee's main field tests at each of the exposure stations at home and abroad is described and the observations made to date are reviewed.

An additional corrosion station has been set up at Sheffield University, where tensile test pieces prepared from the large specimens of the mild steels and irons under test have been exposed.

Further specimens of high-tensile structural steels, chiefly of the copper-chromium type, have been prepared for Part III of the tests. Preliminary details of the experimental programme concerned are given.

Data of a semi-quantitative type on the descaling of the various as-rolled specimens on exposure to weathering continue to accumulate. It has been found that in the case of materials rolled according to normal works practice, the rolling scales on British wrought iron and on ingot iron are more resistant to weathering than those on mild steel. This may partly be the reason why, after one year's exposure at Sheffield, as-rolled specimens of British wrought iron lost less in weight than specimens of ordinary mild steel. The presence of copper, both in mild steel and Swedish iron, was found to reduce the rate of corrosion considerably ; in the case of steel there was no difference between specimens containing 0·2 and 0·5 per cent. of copper respectively.

Other quantitative results for the rate of corrosion of mild steel have been obtained at Woolwich, and the most practical method for removing rust from the specimens after exposure has been investigated. It has been decided to do this by pickling in dilute sulphuric acid in the presence of an inhibitor.

The behaviour of specimens descaled prior to exposure calls for little comment. At Llanwrtyd Wells some difference was observed in the rate of rusting of iron specimens, which, in the early stages, was less for Scottish wrought iron than for Staffordshire wrought iron or ingot iron. At Abisko an appreciably longer time elapsed before the descaled specimens of Swedish iron were covered with rust, as compared with the other materials.

The behaviour of painted specimens also calls for little comment, since the majority of them, other than those painted over a weathered and partially descaled surface, are in very good condition after up to four years' exposure. Attention is drawn to possible differences in the types of failure of the paint film when applied to descaled and to as-rolled surfaces, respectively.

The galvanised specimens exposed at Llanwrtyd Wells are still in good condition after three and a-half years' exposure.

Analyses of the rain water collected at the four main experimental stations—Woolwich, Llanwrtyd Wells, Calshot, and Sheffield—are given, and the losses in weight of the small control specimens of ingot iron and of zinc at most of the corrosion stations, in some cases for several single periods of one year's exposure, are tabulated and discussed. Except at the South African station, corrosion is less at the stations overseas than at those in Britain.

Observations on the painted stands confirm the conclusion already drawn that the priming coat on structural steel work should be of an inhibitive character. Tests have been commenced at Sheffield in which the steel work of the stands was prepared in various surface conditions prior to painting ; some additional paints have been included in these tests.

The results of experiments on the corrosion of steel sleepers under actual service conditions are described.

Section C (Marine Corrosion).—The progress of the tests on steel plates built into the barge "Cactus" is described by J. C. Hudson and R. H. Myers. Inspection has given some indication that mild steel plates finished at a reduced rolling temperature as a result of discontinuous rolling shed their scale in the shipyard rather more rapidly than plates rolled under normal works conditions. It was found at inspections of the barge whilst in commission that most of the corrosion observed had been initiated by mechanical damage. This rendered it difficult to compare the merits of the plates prepared in different surface conditions prior to the initial painting. Plates that had been painted whilst hot on the mill floor were in better condition than the others when the finishing coat applied at the yard was bituminous paint, but in cases where the finishing coat was red oxide paint the whole paint film showed a curious and unexplained tendency to peel off the plate. It is not possible to state whether the application of an extra coat of paint to ordinary plates at the time of fabrication would not have given equally good results. The "Cactus" has been repainted and will be kept under observation.

Examinations of the steel pontoons supporting the floating landing stage at Gosport are reported by R. H. Myers. Some of the plates showed pronounced pitting, and it was concluded that the trouble probably originated several years ago, when an interval of seven years occurred between successive applications of protective coatings. It is probable that three, or at most four, years is the maximum advisable interval between successive "reconditionings." An opportunity was taken to commence some tests on various types of weld metal deposits, and the suitability of the landing stage for the exposure of test plates to marine corrosion is being investigated.

Tests on welded specimens of ships' plate, both of ordinary and of high-tensile D quality steel, conducted by H.M. Admiralty, are reported. The specimens were exposed to various types of marine conditions for thirty months. The conclusion reached was that, on the whole, corrosion troubles should not be aggravated by welding, provided that the process is correctly carried out.

Section D (Laboratory Research Sub-Committee).—The preliminary results of an investigation on metallurgical factors influencing the corrosion of iron and steel are given by R. B. Mears. Those of tests on the scale-covered materials exposed in the main researches of the Committee are of especial interest, in that they show that, whilst the corrosion probability is generally determined by the physical character of the rolling scale, for the materials as tested, it was definitely less for the wrought irons and the ingot iron than for the mild steels.

The systematic tests on totally immersed ferrous materials conducted under standardised experimental conditions at the Chemical Research Laboratories are described by G. D. Bengough and F. Wormwell. The influence of various factors such as the diameter of the vessel and the depth of immersion are fully discussed ; the standard method of testing is described, and suggestions are made for simplified forms of tests. An investigation on the effect of manufacture and composition on the corrosion rates of ordinary iron and steel has shown that, under the particular experimental conditions, these factors are relatively unimportant as compared with environmental factors, although there is some indication that wrought iron corrodes less rapidly than steel.

K. G. Lewis and U. R. Evans report experiments, the results of which give further support to the conclusion that the application of paint to specimens from which the scale has been partly removed by weathering yields much less satisfactory results than when the paint is applied to specimens either with an intact scale or totally descaled by weathering or by other methods. The same authors find that, on the whole, the orders of merit in atmospheric exposure tests of painted and unpainted specimens of different materials are similar but not identical.

J. C. Hudson gives details of further corrosion tests on ferrous wires, of some tests undertaken to elucidate the ageing of hard-drawn mild steel wire, and the results of several inspections of painted specimens at Birmingham and Farnborough. The ageing tests showed a definite increase of 3·7 per cent. in the tensile strength of a hard-drawn 0·22 per cent. carbon steel wire that had suffered a reduction in area of 24 per cent.; with a reduction in area of about 75 per cent. no definite variation in breaking load could be detected. The Birmingham paint tests confirm the value of pickling specimens prior to painting.

Section E (Miscellaneous).—This section includes the results of investigations by the Committee on the corrosion of steel sleepers in mines. It was found that in dry pits no trouble is experienced by corrosion. Details are given of the inspection of two old ferrous structures—a wrought iron rail laid in 1832, and the old cast iron bridge erected at Coalbrookdale in 1779.

After referring to the very great loss which the Committee had sustained in the death of Mr. Dickenson in November and of Mr. F. F. Hunting only two days before, Dr. Hatfield said it would be clear from the Report that the work had now reached very large dimensions. There was an extensive and official research going on under the direction of Dr. J. C. Hudson and the Committee had corrosion fields all over the world. That, however, would not be possible without very substantial financial assistance, and on behalf of the members of the Committee he acknowledged their indebtedness to the Iron and Steel Institute and also to the British Iron and Steel Federation for the funds which had been provided. That corrosion research was now costing £2000 per annum, and during the last four or five years something like £10,000 had been spent in the endeavour to solve in a systematic manner many of the problems with which the members of the Institute were concerned. One of the very valuable effects of the work of the Committee was to eliminate variables and impressions and to confirm facts.

Dr. J. C. Hudson, introducing Section B of the Report, which was devoted to the Committee's field tests on atmospheric corrosion, added that the Committee had now prepared a number of specimens of copper-chromium and other high-tensile structural steels which would be exposed to similar corrosion tests at Sheffield, South Africa, Singapore, and Abisko, in the course of the next month or so. In addition to an unalloyed 0·2 per cent. carbon steel, there were similar steels containing 0·5 per cent. of copper and 1 per cent. of chromium ; three copper-chromium steels, ranging up to 0·5 per cent. of copper, 1 per cent. of chromium, and 1 per cent. of manganese ; and a steel with 0·3 per cent. of silicon, 0·6 per cent. of copper, and 1·6 per cent. of manganese.

Referring to Section C, which relates to marine corrosion and deals with tests on the steel plates built into the barge "Cactus," he said that a number of steel plates had already been rolled for similar tests on a sea-going Admiralty trawler, and are now being built into the ship. In addition, some small stationary specimens were now being exposed in some preliminary marine corrosion tests at Gosport.

Other portions of the Report were then briefly introduced by Dr. G. D. Bengough, Dr. U. R. Evans, and Dr. R. B. Mears, who dealt respectively with the contributions in the Report under their names.

DISCUSSION.

Mr. T. H. Turner (L.N.E.R.) remarked that from the users' point of view we could hardly be satisfied with the statement that a ship will not corrode on account of the steel. Moreover, paint was likely to hide defects which could develop and cause serious trouble, and the aim must still be to get something which would not require painting at all, although perhaps the paint industry would not like that. It was interesting, he continued, to see how acid all the natural rain waters were in industrial areas, which indicated that in such areas there was a definitely corrosive atmosphere. In the case of rail wear in tunnels, which was referred to, there was the combination of an acid atmosphere and humidity which caused an extraordinary reduction in the life of the rails. Speaking from the practical point of view, Mr. Turner asked how much were we justified in spending to clean the steel, say, of a bridge where one part was nicely covered with scale, whilst the rest of the paint appeared to be in good order, and would only get another coat of paint. How far could one go in thoroughly cleaning the steel ? Looking at the tests which had been carried out at Woolwich, he noticed a very surprising difference between sand-blasting and shot-blasting. From that series of tests it seemed that the resistance to corrosion depended on the consolidating effect of the surface. Perhaps the sharp indentations caused by sand-blasting resulted in a surface that was more easily attacked, and it almost seemed that it would be better to substitute shot-blasting for sand-blasting on outside surfaces before painting, where such an operation was possible.

Mr. E. J. George expressed the hope that the investigation into the causes of corrosion would not produce a result which Mr. Turner seemed to contemplate, viz., a steel so perfect that it would put the steel maker almost entirely out of business !

Mr. A. Hutchinson said he sympathised with Mr. George and added that he personally was torn between his love of scientific truth and scientific investigation, and the necessity for making a steel which would sell, but which would not last too long !

Dr. Lewis Dale said the most striking feature of the Report was the manner in which all the work has been brought on to a scientific basis. He criticised the variation in the pH value of the water at Woolwich and the possible influence on the results by using a water of a certain value for a particular period and a different value for another period. He suggested that instead of having a different pH value for different experiments, tests for a period of, say, one year should have been carried out with water of one pH value.

Dr. L. C. Bannister remarked that Teddington tap water appeared to be more corrosive than the usual tap water. Perhaps that was not so surprising having regard to the conditions of the experiment, which resulted in the dissolved oxygen being very much greater in Teddington tap water than in the usual tap water, but surely that would not be the case under practical conditions. He suggested that such tests should not be based on exceptional conditions.

Mr. A. W. Brown, dealing with Section C of the Report, relating to marine corrosion, suggested that the insides of tankers exposed to sea water intermittently might be examined, inasmuch as the chance of mechanical damage, referred to in the case of the barge "Cactus," was comparatively slight under those conditions. The findings of the Committee with regard to scale *versus* de-scale conditions would be welcome, and particularly so with regard to the probable case of weathering off scale produced by reduced rolling temperatures. He asked if the coal or coke used for heating the rivets for the "Cactus" was relatively sulphur free.

Painters only talked of two classes of paint, namely, an oil paint in which the medium was linseed or some similar oil, and compositions in which the medium was naphtha or some similar spirit. The view was held that a combination of the two was never satisfactory and there was some evidence of that in what was said in the Report concerning the repainting of the "Cactus." He suggested that the Committee should carry out some tests on the paints that it was using with a view to arriving at some information on that matter.

Referring to the Admiralty welding tests, Mr. Brown said that although these were very interesting, they had lost a great deal of their practical value owing to the lack of data with regard to the electrodes used. It was the fact that a relatively poor weld had been examined in the present case, as was illustrated by the X-ray and other mechanical tests, and it would be a pity if the further investigation of weld metal should be dropped in view of the increasing importance of the application nowadays of electric welding for shipbuilding. Undoubtedly, a good deal of information which would have been welcome was not available because of the lack of data with regard to the electrodes used.

Dr. W. H. Hatfield, replying to the discussion, said that scientists realised, at any rate in some measure, the commercial realities suggested by Mr. George, and if Mr. George and other industrialists would only give more credit to the scientists, the products of the manufacturers would be of a higher standard, and would have a much greater command of the world's markets. In his own case, his colleagues had found one principle to be a very successful one, namely, that the intrinsic commercial value of a product not only in composition, but in quality, had a complementary monetary value which it was impossible to get away from, and the more the scientific representatives of industrial establishments were permitted to speak the truth, the whole truth, and nothing but the truth to enable the industrial organisation, the buyers, and the sellers to appreciate the realities and know what the realities were, then the sounder would be the basis of our industries and the greater our success.

Commenting on Mr. Brown's remarks with regard to the interior examination of tankers, Dr. Hatfield said that the Committee would be only too pleased to take full advantage of any opportunities that were placed at its disposal. As regards rivets, the point mentioned by Mr. Brown was one of the matters which the Corrosion Committee was trying to get down to, namely, to ensure consistency of composition and quality, not only in ship plates, but also in rivets. Finally, as regards welding, Dr. Hatfield said that Mr. Meryon, who had been responsible for these tests, would be very glad indeed to place at Mr. Brown's disposal full information as to the electrodes employed.

The next paper presented was entitled "Further Determinations of the External Heat Loss of Blast-Furnaces," by D. F. Marshall. The author's summary runs as follows :—

EXTERNAL HEAT LOSS OF BLAST-FURNACES.

The paper is a record of an experimental determination of the external heat loss from four blast-furnaces, selected to cover

a wide range of rate of production, type of product, and general practice. The influence on the heat loss of various factors, such as the rate of drive, the life of lining, cooling winds, exposed sites, the use of bosh tuyeres and the water cooling of shafts, has been investigated, and an attempt made to measure their effect on furnace operation, in terms of fuel consumed.

The results indicated that the external heat loss was largely a function of the superficial area of the furnace and was considerably lower than the estimates previously given. The relationships existing between the heat losses from the furnaces examined did not appear to be materially affected by changes in operation from furnace to furnace, or on one furnace.

In all cases the cooling water used accounted for more than 83 per cent. of the total heat loss, and it seems probable that a study of this loss might result in improvements in furnace operation.

The heat losses by radiation and convection from the shaft, and by conduction through the ground, were relatively small.

Discussion.

Mr. R. A. Hacking said that these investigations confirmed the conclusion drawn from the author's paper of 1933 to the effect that the heat loss had, in the past, been greatly over-estimated, owing, no doubt, to the fact that it was assessed by difference from the necessarily complex thermal balance sheet of the whole process, and as a result was subject to an accumulation of errors. When one reflected that some of the most important items on the debit and credit sides of the thermal balance sheet were based upon heats of formation, specific heats, &c., which were not known accurately, the discrepancy was not surprising. It was significant, also, that the discrepancy was invariably in the same direction. Referring to shell temperatures, he remarked that all the furnaces examined had been working for some considerable time prior to the test runs, and the shell temperatures recorded would undoubtedly be dependent in no small degree upon the erosion which had already taken place. A similar investigation upon a furnace as soon as it had settled down after relining, say, three or four weeks, would be extremely interesting.

Mr. F. J. Bailey said there were two points the importance of which he did not think Dr. Marshall had sufficiently realised. In the first place, it was possible in any furnace carefully to determine the external heat loss, as was pointed out in 1928 in the original paper on blast-furnace operations by Mr. Evans, but although the determinations of that heat loss by difference might have been in error, that was not quite the same thing as trying to arrive at how much fuel it was necessary to burn in the furnace to make that heat loss good. There was a very wide margin and the actual amount of fuel burned might be from three to five times the amount of the heat loss, since the gases were leaving the highest temperature zone at a very, very high temperature. It was true that energy was returned in the form of reduced ore, but that did not affect the thermal balance sheet of the furnace for the moment.

Mr. R. C. Tucker suggested that the paper indicated that heat loss in a blast-furnace was not nearly so important as some of the old people seemed to make out, and therefore many of the so-called improvements in design were merely fads. The paper also showed that of the heat loss that took place a surprisingly large proportion was due to water cooling, but in spite of that the furnaces to-day were producing iron at unbelievably low fuel consumptions as compared with the old furnaces which had no water cooling. That was a very great point in our assessment of the various factors which governed blast-furnace operation and efficiency.

Mr. A. F. Webber challenged the conclusion in the paper that the heat loss had hitherto been seriously over-estimated and pointed out that the author was not in a position to come to that conclusion yet because he had taken no account of the heat loss in the cooling water. At the same time, he confessed he could offer no practical suggestion as to how that could be done. Admittedly, it was difficult, but the preponderating proportion of heat loss due to the cooling water was of the utmost importance and, sooner or later, it would have to be tackled.

Dr. Marshall, in a few comments on the discussion—he had no time to give his full reply—informed Mr. Webber that in the case of the furnaces covered by the paper, the majority of the water was in an enclosed system and the problem of evaporation, therefore, did not apply to the extent Mr. Webber had indicated, although it applied to some extent.

A paper entitled "An Effect of Oxygen and Sulphur on Iron in Scaling," by J. H. Whiteley, followed. We give the author's abstract.

IRON SCALE.

A network structure which forms at the boundaries of either α or γ surface grains when steel is scaled is described and studied. It is revealed by the usual etching reagents, including cupric, and its intensity depends, in part, upon the temperature and length of heating. The structure does not penetrate far, and is primarily due to the presence of oxygen in the scale exceeding the ferrous-oxide phase requirement. When steel is welded by wash heating, the structure is usually to be found at the weld junction. It disappears, apparently by diffusion, when heated in the absence of oxygen at the higher temperatures in both the α and γ ranges, the rate increasing with the temperature. In purer materials, such as electrolytic iron, the structure is either extremely weak or fails to appear. This variation is traced to the influence of sulphur, which causes intensification, but, along with it, other elements may also have some effect. The action of sulphur on scale intrusion at the austenite grain boundaries is also discussed. Finally, the characteristics of the structure are compared with those of the ferrite bands in the banded structure of rolled steels, and the similarity is sufficiently marked to suggest that both are due to the same cause, namely, a heterogeneous distribution of oxygen and sulphur in the metal.

Discussion.

Dr. W. H. Hatfield said he regretted that the cupric etching reagent had been used because it was most misleading, and was not a quantitatively exact scientific means of attack. With regard to the general proposition of oxidation along the grain boundaries of gamma iron, there was clear support for the practical contention of the author, but there was no need to adopt his method of approach. It could be found by ordinary methods of examination of the cross section through the scaling of the material and the permeation of the scaling along the grain boundary; but he had found no evidence of the permeation of the steel much beyond the actual surface of contact between the permeating oxide.

Dr. C. H. Desch said he felt that the author had made out a very strong case for the structures described by him being due to oxygen, but the action was a very complicated one. The fact that those structures had been arrived at by scaling various irons, &c., emphasised the real importance of starting out with a perfectly pure iron and trying the successive actions of oxygen, sulphur, and other elements, and working out, quantitatively, the relation between those elements. He did not agree with Dr. Hatfield as to the unreliability of the cupric reagent, but even admitting that that reagent was unreliable, the fact that those non-metallic inclusions existed with a difference in structure in their neighbourhood produced by the cupric reagent surely showed that there was something different in the metal in the neighbourhood.

Professor J. H. Andrew said a very considerable amount of work had been done on the question of oxygen in steel at Sheffield, but what he could not quite understand was why the oxygen disappeared by diffusion and went into solution on heating. Was there any possibility that Mr. Whiteley polished off the layer at the second treatment? He would like to know exactly the distance to which the surface was removed after polishing the second time, and whether there was any possibility that the second polishing removed the oxidised surface.

Dr. T. Swinden spoke of experiments which he had carried out with steels of different composition from those used by the author, the results of which however, confirmed what was said in the paper. A great deal of work was still necessary to reach a complete explanation of what the network structure really meant. In his own case the maximum depth it had been possible to obtain was $^1/_{1000}$in., and that required quite a lot of explanation.

Dr. L. F. Northcott said he saw no reason why the oxygen should not diffuse in the iron in the form of ferrous oxide. In sulphur-free material the oxygen might be there as free oxygen or as ferric oxide, whilst in the sulphur-bearing material it might exist as gaseous sulphur dioxide. The suggestion that ferrous oxide was not important he considered needed further confirmation. He would imagine that there would be at least a layer of ferrous oxide and that it would play an important part.

Professor C. A. Edwards said he understood that the author supposed that the disappearance of the network on heating was really due to the absorption of the oxygen in the ferrite, but was it not possible that that was quite wrong and what was happening was the reduction of the oxygen which was present by any carbon which might be in the steel, even if that were as low as 0·02 per cent. or even less?

Dr. A. McCance remarked that the association of sulphur in ghost lines had always been somewhat difficult to explain, and it was possible that that paper, if it did not give the whole explanation, would at least give a clue to what was taking place.

The author, replying to the discussion, suggested that Dr. Hatfield required more practice with the cupric etching reagent! At the same time, he himself had not depended upon cupric reagent, although he was quite satisfied with it. He agreed with Dr. Hatfield that there was no evidence so far of oxygen in the banded structure, and, as a matter of fact, he had been trying to put that forward in his paper. Nevertheless, even if there was a resemblance of it, that was still no proof and there must be actual proof by direct estimation that oxygen was in the banded structure. He had used small specimens as a matter of convenience because they were quicker to work with. He could not tell Dr. Northcott in what form the oxygen went into the iron, because he was as puzzled about it as anybody else. With regard to Dr. McCance's remarks concerning excessive sulphur, he said that if the scale was washed away it was necessary to be cautious that there was not an intermediate amount of sulphur which might do more harm than a large amount. The whole thing, however, required further investigation, and he had put it forward in the hope that others would follow it up.

Professor J. H. Andrew and Mr. G. T. Richardson then presented a paper entitled "An Investigation of Spring Steels." The authors give the following abstract.

SPRING STEELS.

The following is an account of an investigation of the manufacture of spring steels, from the billet stage to that of the heat-treated plate. The first part deals with silico-manganese steels, and the second with chromium-vanadium and plain carbon steels in addition.

Details of heating for rolling, of rolling, and of the final heat treatment are given.

The important feature emphasised throughout this paper is the decarburised layer resulting from furnace treatment at different periods of the process. It has been shown by previous workers that a decarburised surface results in a considerable diminution in the fatigue strength.

Hardness measurements and micro-observations have shown that a silico-manganese steel is the most susceptible of the three to decarburisation. This decarburised layer is reduced to a minimum by a high temperature of soaking prior to rolling, and the qualities of the springs are improved by a high degree of reduction per pass during rolling.

It has been shown that in the final hardening and tempering process a thick tenacious scale results in an insufficient hardening of the steels, whereas a clean decarburised surface gives rise to a greater hardness in the centre of the spring plates.

Silico-manganese steels require a high temperature for hardening to produce homogeneity throughout the plate, whereas chromium-vanadium steels are much less susceptible to temperature, and are easily treated to give a uniform hardness value throughout.

From the purely metallurgical standpoint it appears that the chromium-vanadium steel is the easiest to treat, and, generally speaking, gives the most satisfactory results.

Discussion.

Dr. M. L. Becker said that the work described in this paper seemed to be a valuable amplification of one section of the work on the fatigue of springs in which Dr. Hankins and himself were engaged at the National Physical Laboratory and reported upon to the Institute from time to time. When they published their results relating to the effect of a decarburised surface layer on the fatigue properties of springs and forgings, several people expressed considerable doubt as to the possibility of applying the results in practice. Hence, it was extremely gratifying to know that the Committee of the Sheffield Spring Makers was giving the matter such careful consideration. No fatigue tests were quoted in the paper, and it might, therefore, not be out of place to recall that quite a thin decarburised surface layer on springs might account for the loss of nearly half the intrinsic fatigue resistance of the material.

Continuing, Dr. Becker dealt with a number of points of detail in the paper.

Commenting on the conclusion in the paper that heavy scale on the surface of spring plates plays an important part in the efficiency of the quenching operation, Dr. Becker said that whilst that was undoubtedly true it seemed that the effects of large grain size in promoting deep hardening characteristics had been rather overlooked and some of the effects attributed to the presence or absence of scale might, to some extent, have been brought about by the differing grain size induced by prior treatment. The only serious criticism of the results seemed to lie in the distinctly poor uniformity in hardness which was obtained in the case of the silico-manganese steel, that uniformity not being so good as Dr. Hankins and himself obtained with the particular steels they had used. Possibly, the difference was due to composition, both the carbon and manganese being lower in the authors' case. Perhaps steel makers would discuss that point, since the authors' results scarcely did justice to a type of material usually regarded as reliable in that respect. The steel used by Dr. Hankins and himself oil quenched fairly uniformly.

Dr. T. Swinden said he agreed with Dr. Becker that the composition of the silico-manganese alloy used was not typical of oil-hardening silico-manganese spring steel. It was more usual to have 0·55 per cent. carbon and a rather lower silicon which gave a better hardening-ability. The suggestion that the degree of decarburisation might actually be increased during the rolling process was a new thought. There seemed to be some difficulty about the suggestion that practical advantage might be taken of the proposals in the paper to produce a steel with a very large grain size and then to roll it with 80 per cent. reduction per pass. That, certainly, should be linked up with other matters such as the risk of cracking in hardening and also the elastic ratio and fatigue values of the material. Whilst agreeing with the general statement that chrome-vanadium steel was superior to silico-manganese or carbon steel, Dr. Swinden said that steel-making, particularly for the automobile industry, was largely a matter of economics. Speaking generally, he said it was a very important thing that the industry in Sheffield should have had the advantage of the study of this subject by Professor Andrew and his colleagues in the scientific manner they had; but it was very essential that the results should be linked up with the practical production of the best type of springs.

Mr. E. Millington (L.M.S.) spoke of work that has been carried out under his supervision and mentioned that raw linseed oil was used for quenching. The temperatures of quenching were 890 deg. to 900 deg. Cent., but areas of differing hardness were obtained which were difficult to explain. Eventually, it was found that by increasing the temperature of tempering, it was possible to arrive at uniform hardness, more or less, throughout the section. The temperatures which Professor Andrew had mentioned as necessary for giving uniform hardness were, in his view, prohibitive from the practical point of view from two aspects. In the first place, they introduced heavy scaling, and in the second place, they gave rise to distortion. As to the,

inferiority of silico-manganese steel as compared with carbon steel, Mr. Millington asked Professor Andrew how he could get a carbon steel to give the physical properties demanded for springs in the oil-quenched condition. Personally, he had not been able to do it. If water was used, then he could only say that his experience of the manufacture and behaviour of the two steels was that silico-manganese steel was very much superior both from the quenching point of view and also behaviour in service.

Mr. Frost said that an important point raised in the paper from the spring makers' point of view was whether the loss of carbon at the surface or oxide penetration was responsible for the very great lowering of the fatigue strength in spring steel which was so well known. Spring makers would be seriously handicapped in their efforts to assist in a possible solution of the problem as a whole until this particular question was determined, and he hoped there would be further investigation of it.

Mr. T. H. Sanders remarked that the carbon content of the silico-manganese steel, namely, 0·45 per cent., was low, as most standard steels for oil hardening contained from 0·5 to 0·6 per cent. No doubt, however, there was a reason for the 0·45 per cent. It was worth while specially noting that the minimum of billet, bar, and spring plate decarburisation was on a sample in which the billet was heated in a smokey atmosphere. The old-time technique of Sheffield was based largely on smokey atmospheres for both re-rolling and spring bar heat treatment, and there was little doubt that that practice reduced decarburisation probably partly by surface protection and partly by the reintroduction of carbon into the surfaces from the smoke. He believed the National Physical Laboratory found that they could replace carbon in decarburised surfaces by painting the bar with graphite before heating. The probability was that the second heat treatment for hardening the spring plate actually removed the decarburised surface, which passed away in the scale. That formed a good argument for the double-treatment system, well known in Sheffield many years ago and even now specified on rare occasions. In that the plate was first heated and bent, and then allowed to cool, being reheated for the hardening treatment. By that means it seemed logical to believe that two layers of scale were removed and that the final surface should show very little decarburisation. There was no doubt of that in the minds of those who really knew of the superiority of the springs so produced, but commercial considerations of cheap production obviously checked the general employment of that method. The influence of rolling had been rightly emphasised, and it should also be mentioned that the sectional area was a factor in obtaining uniform results with uniform treatment. On that account he had long made it a practice to make a line of demarcation at $\frac{1}{4}$in. thick with a lower carbon for the thinner plates than for thicker. Finally, Mr. Sanders said that the comparisons given for the silico-manganese and chrome-vanadium were of great interest, but in practice the difference between the two qualities was not seriously marked, except for the higher price of chrome-vanadium, which militated against its use. The whole matter turned on the treatment of the spring plate, as it was quite possible to produce either quality in good or bad condition for spring service.

Professor Andrew said he would reply in writing.

Determination of Oxides in Steel.

There was time to discuss only one more paper on Wednesday afternoon, May 1st, viz., that by Mr. T. E. Rooney and Mr. A. G. Stapleton, entitled "The Iodine Method for the Determination of Oxides in Steel," in which the estimation of oxides in steel by the solution of a sample in an alcoholic solution of iodine is described.

Discussion.

Dr. C. H. Desch said the method was not applicable to steels containing any appreciable quantity of alloying elements. With ordinary steels, however, there seemed to be no great difficulty provided the sulphur was low and that was the question which would next have to be examined with some care, viz., the degree to which sulphides were left unattacked. The most important improvement was the use of methyl alcohol instead of ethyl alcohol, and using very carefully dried methyl alcohol, the action on the oxides seemed to be quite negligible, but the same could not be said of the sulphides.

Dr. W. H. Hatfield said the Ingot Committee had discussed oxygen determination in detail, but was in a difficulty, inasmuch as a number of the members—in which he himself was not included—thought that the iodine method should be perfected and that any money resources available should be devoted to that. There were others on the Committee, however, who did not agree with that proposal, nor with the suggestion that the iodine method should be perfected before any results were issued. Their view was that oxygen results should be published in the next Report of the Committee. Their idea was to describe in detail the process employed and to say that the results published were those obtained with the process. The vacuum extraction method and the iodine method were the two methods being employed at the present time, but with every confidence in the investigators, with the best intentions in the world, and with all the ability at their disposal, he did not feel that there was much hope of a great mass of accurate quantitative data on oxygen immediately.

Mr. Rooney, in a brief reply, said Dr. Hatfield had referred to the chaotic state of oxygen determination, and appeared to be rather pessimistic, but he did not think he was saying too much in suggesting that in less than thirty years we should be able, if the work was supported in this country, to give a definite answer at least as regards carbon steels, and probably it would be possible at the same time to nibble at the alloy steels.

This concluded the annual meeting of the Institute.

The Royal Society's Conversazione.

THE exhibits at Burlington House on Friday evening of last week reflected as usual the all-embracing outlook which the Royal Society has upon Science. Many of them, tempting us from our allegiance, invited us to stray along paths remote from the field of engineering and on more than one occasion we succumbed to the attractions which they presented. At one time we found ourselves lingering before a table, occupied by exhibits from the Science Museum, on which were displayed Fox Talbot's early photographic apparatus and specimens of the work which he produced with it. Knowing, as we do, the difficulties which even to-day the amateur finds in obtaining permanency in his prints, we were surprised to find exhibited a photograph taken by Talbot exactly one hundred years ago. It showed a window in Lacock Abbey and was made by the "photogenic drawing" process, that is to say, by means of a camera obscura and a piece of paper washed with common salt and silver nitrate. Five years later, in 1840, Talbot invented the "calotype" process, the first using both negative and positive, and thereby laid the foundations for all subsequent advances in photography. Actual examples of these early calotypes, representing scenes at Lacock Abbey and conveying a curious sensation of having been stolen from the irrecoverable past, were displayed.

On the same table the Museum showed an instrument inviting us to go still farther back into the past, a microscope made round about 1675 by Christopher Cock for Robert Hooke, an elaborately ornamented leather covered apparatus with little outward resemblance, but much similarity in general principle, to a modern compound microscope. Elsewhere Mr. George H. Gabb, an indefatiguable collector of scientific antiquities, showed a pastel portrait of Dr. John Jeffries who with Blanchard was the first to cross the English Channel in a balloon. That historic event occurred on January 7th, 1785, a hundred and fifty years ago. The balloon carried an "air mail" which was dropped after the French coast had been crossed. A copy of Jeffries' "Narrative of Two Aerial Voyages," published in 1786, and now a bibliographical rarity, was exhibited alongside the portrait.

Passing onwards we renewed our interest in that mystery of the Libyan desert, the pale green or light brown silica glass which Dr. L. J. Spencer discovered occurring sporadically in lumps weighing up to about 16 lb. on the sandy surface of the "streets" or valleys between the ranges of dunes in the Sand Sea. Palæolithic man fashioned implements from the material and to-day, as the exhibit showed, it may be cut like a gem stone for ornamental use. Renewed investigations made on an expedition last December failed completely to associate the material with any geological feature of the neighbourhood in which it is found, a restricted area measuring about 60 miles by 120 miles. The suggestion that the glass is of extra-terrestrial origin, that it is, in fact, a "cosmic gem," still remains as likely to be true as any other explanation.

Our journey into the past was brought to an end before the actual skeletons—restored, it would seem, in places—of an adult and a young bipedal herbivorous dinosaur recovered from the Wealden deposits of the Isle of Wight. The full-grown specimen, resembling in form a pot-bellied lizard with a sturdy pair of hind legs and a long thick tail, was, to judge from a reconstruction, a placid looking creature, not too big to keep about the house as a pet, but it was one of Nature's experimental failures and dropped behind in the evolutionary struggle.

There was no lack of exhibits to remind us of the restless advance of scientific development in the modern world. In one of the rooms downstairs we found the Chemical Research Laboratory of the Department of Scientific and Industrial Research exhibiting what must surely be one of the latest and perhaps one of the most valuable stages in the development of that amazing material or group of materials known as synthetic resin of which bakelite is chiefly familiar. Popular imagination was recently stirred by the news that synthetic resin could now be produced in a transparent form like glass which could be turned and machined and was practically unbreakable. The Laboratory exhibited specimens of this material produced, we understand, by a chemical process different from that developed by Imperial Chemical Industries. In appearance the substance although transparent was not wholly colourless. Very curiously it resembled quite closely to an outward inspection the silica glass from the Libyan desert of which we have already made mention. But it was not by this material so much as by some kindred bodies that our practical interest was attracted. One is apt to think of the synthetic resins as constructional materials. We do not naturally associate them with any chemical functions as for example substitutes for zeolites for water treatment purposes. Yet the Laboratory showed that certain members of the family have properties of this kind which are now ripe for commercial application. Ordinary sea water from Plymouth Sound was passed through four tubes of which the first and third contained a synthetic resin, in the form of a hard granular powder, prepared from tannin material while the second and fourth contained a synthetic resin prepared from aniline. The water issuing from the fourth tube was completely free from inorganic matter. We sipped some of it and found it palatable and without trace of its salty origin. The tannin material, we learnt, removes the metallic constituents of the sea salts while the aniline material completes the work by removing the acid constituents originally combined with the metals. In time the materials lose their efficacy but they may be restored to full activity in the same manner as that used in connection with existing domestic water softeners. The materials from which the resins are made cost only a few pence per pound. The process is applicable to the softening of hard waters and to the purification of industrial effluents possibly with the recovery of valuable products which would otherwise be lost. While it may not as yet be available for converting sea water into drinking water, it is claimed to be satisfactory from all points of view for converting sea water into boiler feed water. It should be noted that unlike other water treatment processes, it removes the impurities. It does not add anything to the water and in particular it does not act simply by converting the impurities into other forms of contamination of supposedly less harmful character.

The exhibit of the Metropolitan-Vickers Electrical Company, Ltd., provided another attraction and illustrated, like that just mentioned, the development of a field already partially explored. The company's exhibit consisted of apparatus for the detection of cracks in steel or other magnetic material. A crack or other flaw, internal or external, in a magnetic material causes a discontinuity in a magnetic field existing in the material. The novelty of the exhibit lay in the means employed for rendering the distortion of the field visible. Two types of detector were shown. One made use, as usual, of finely powdered or colloidal iron particles suspended in oil. This fluid was confined in a thin layer between a circular brass back and a glass top the whole forming a unit resembling a mirror of the "vanity" pattern carried by ladies. With the oil and iron particles thoroughly mixed by shaking with a rotary motion the "mirror" is placed with its brass back in contact with the article to be examined, that article having previously been magnetised. As the particles settle in the oil they migrate to the spots where the magnetic field is disturbed by the presence of a defect in the material and clearly reveal its form and position. A curious application was demonstrated. By means of a magnetised rod, constituting a magnetic pencil, a plain piece of steel could be written upon invisibly. When the "mirror" was applied to its surface, the locally magnetised lines produced by the pencil became clearly visible. The writing could be rubbed out by means of the opposite pole at the other end of the pencil but if not destroyed by heating it would remain, ready to be revealed by the mirror, for an apparently indefinite time. A practical workshop application of the device was shown. Case-hardening alters the magnetic properties of steel. The detector can therefore be applied to reveal the depth of case-hardening in sectioned material. It was also demonstrated as a means of revealing the well-known fact that nickel-chromium stainless steel is normally non-magnetic but becomes magnetic after being work-hardened. The device, we learnt, is now receiving an important practical application as a means of detecting cracks in rails, particularly at places where wear has been made good by building up by means of welding.

The second means exhibited by the company of detecting the discontinuity of the magnetic field consisted of an apparatus through which the body to be examined, say a rod with an internal flaw, could be passed with a continuous motion. The rod subjected to a magnetic field of suitable strength and

direction passed within the apparatus close to a short magnetic needle mounted to turn on an axis which also carried a small mirror. A beam of light was reflected from the mirror on to a scale. The passage of a flaw either in the interior of the bar or on its surface was revealed by a very decided movement of the spot of light first to one side and then to the other as the hump in the magnetic field moved across the needle. The indication given can easily be arranged to be audible instead of visible. It would appear that the system might be applied to the continuous inspection of material as delivered from the rolling mills. In both cases satisfactory results are dependent upon a careful choice of the strength and direction of the magnetic field applied to the body under inspection. It is very desirable that the direction of the field should be as nearly as possible at right angles to the direction of the crack or flaw to be detected. As it was put to us, a river forms far less of an obstruction to one walking along its bank than to one trying to cross it.

Of the other exhibits we have space to mention only a few briefly. The General Electric Company showed two examples of modern hot cathode sodium vapour discharge lamps, one for laboratory use and the other for colour floodlighting. The Cambridge Instrument Company exhibited an instrument for measuring or recording the optical density of solutions by means of photo-electric cells. The Admiralty's Department of Scientific Research and Experiment demonstrated a new type of repeating magnetic compass the action of which depends upon the change of impedance experienced by a wire of "mumetal" when an alternating current is passed through it. Sir Robert Hadfield gave a demonstration of the use of the petrological microscope for the examination of steel furnace slags and for the study of rocks in relation to their abrasive characteristics in stone-crushing machinery. The National Institute of Industrial Psychology showed apparatus used in a research into the psychological and physiological qualities necessary in motor drivers.

Torque Converters.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE paper on hydraulic couplings, which Mr. H. Sinclair presented before the Institution of Mechanical Engineers on April 26th was rounded off last Friday May 3rd by two papers dealing with torque converters, the complementary aspect of hydraulic transmission of power. The first of these additional papers dealt with the Lysholm-Smith torque converter and was the work of Dr. H. F. Haworth of Leyland Motors Ltd. and Mr. A. Lysholm of the Aktiebolaget Ljungströms Angturbin, Sweden. It was presented by Dr. Haworth. The second paper dealt with Voith turbo transmissions and was written by Dr.-Ing. Wilhelm Hahn of the J. M. Voith works, Heidenheim. It was presented in Dr. Hahn's absence by Mr. Sinclair, the author of the paper presented a week earlier.

The President, Col. A. E. Davidson, opening the discussion, remarked that at the War office the use of hydraulic transmission for motor lorries had been discussed as long ago as 1904. A hydraulic transmission system had to be very good indeed to surpass mechanical gearing with ground teeth in conjunction with a correctly designed clutch. As mechanical engineers however the members of the Institution ought to encourage the development of hydraulic transmission in its application to oil-mechanical locomotives in competition with oil-electric locomotives.

Professor F. C. Lea commented upon the form of efficiency curve exhibited by a torque converter, characteristically a parabola with its maximum ordinate occurring at a comparatively low speed. He thought that the small range over which the maximum efficiency held good and the necessity for cutting out the torque converter and using a direct coupling to avoid the drop in efficiency at full speeds constituted a point giving rise to a fundamental difference in the application of torque converters to road and rail purposes. The inclines to be ascended on the road were steeper than those on a railway, but the climbs on the railway generally lasted longer than those on the road.

Mr. A. E. L. Chorlton asked the authors to state what developments they foresaw for torque converters, whether for instance there was a possibility of their being used analogously to electric transmission on multi-motored trains. He would have liked to have heard more about the heat dissipation in torque converters. The fall in the efficiency curve at high speeds suggested that it might present a serious problem.

Dr.-Ing. H. Föttinger supplemented the remarks chiefly of a historical nature which he made at the previous meeting regarding the early days of the development of hydraulic couplings and torque converters. He expressed his gratitude to British engineers for their courage in taking up the development of hydraulic transmission at a time when it was looked upon with some doubt by his own countrymen. Referring farther to the recent developments in hydraulic transmission at which he hinted in his previous remarks he said that they would result in a reduction of the losses by 50 per cent. and would have the effect of making the efficiency curve of a torque converter much flatter than at present.

Mr. C. J. Hyde Trutch thought that the efficiencies mentioned in Dr. Hahn's paper were somewhat misleading. There was another efficiency which might be much more important than the ratio of the output to the input of the transmitter namely the ratio of the power applied at the road or rail to the amount of power carried for the propulsion of the vehicle. With a torque converter working in conjunction with an internal combustion engine it would appear that that ratio was never more than about 67 per cent. He questioned, too, whether the shockless characteristic claimed for hydraulic transmission was as complete as it was said to be. In large torque converters was there, he asked, any sign of excessive vibration of the blades ?

Capt. W. J. Wakeley asked for information concerning the effect of the use of torque converters on fuel consumption and concerning the first cost and maintenance charges. He expressed doubt as to whether torque converters possessed any advantage over epicyclic gearing in conjunction with a hydraulic coupling. What effect had a torque converter on the acceleration of a vehicle fitted with it ? Was it not a fact that the acceleration was slow ?

Mr. T. Hornbuckle said that the combination of a torque converter with a hydraulic coupling seemed to him very attractive. The use of movable vanes to increase the efficiency of a torque converter at high speeds did not appeal to him quite so much particularly for railway work. It was always open to question to what extent increased efficiency should be sought at the expense of added complexity.

Mr. Sinclair with the President's permission combined his reply with some comments on the other paper. The Lysholm-Smith torque converter, he said, made use of a double friction clutch and a free wheel to cut out the converter and obtain a direct drive at high speeds. The Voith system employed a fluid coupling for the same purpose the coupling being gradually brought into use as the converter was being shut down. The Lysholm-Smith system gave an efficiency of 100 per cent. on the direct drive as compared with the 98½ per cent. efficiency of the Voith direct drive but with the Voith system the drive could be used for regenerative braking on a down gradient whereas with the Lysholm-Smith system the introduction of a free wheel prevented resort to such a useful expedient. In any event when as was actually the case on a railway the fuel costs amounted to only about 10 per cent. of the total running costs a gain of 1½ per cent. in the efficiency of the direct drive was not of very great consequence.

Dr. Haworth called upon to reply briefly to the discussion expressed his disinclination to be drawn into a discussion of the relative merits of competitive designs of power transmission systems, hydraulic, epicyclic or otherwise. A few words from Mr. Lysholm closed the discussion.

During the discussion someone, we think it was Mr. Sinclair, asked who Mr. Smith was. The question was not answered at the meeting but in the interests of technical history we may record that Mr. Smith is a fellow-countryman of Mr. Lysholm, although he is of distant English extraction.

Water from the Greensands.

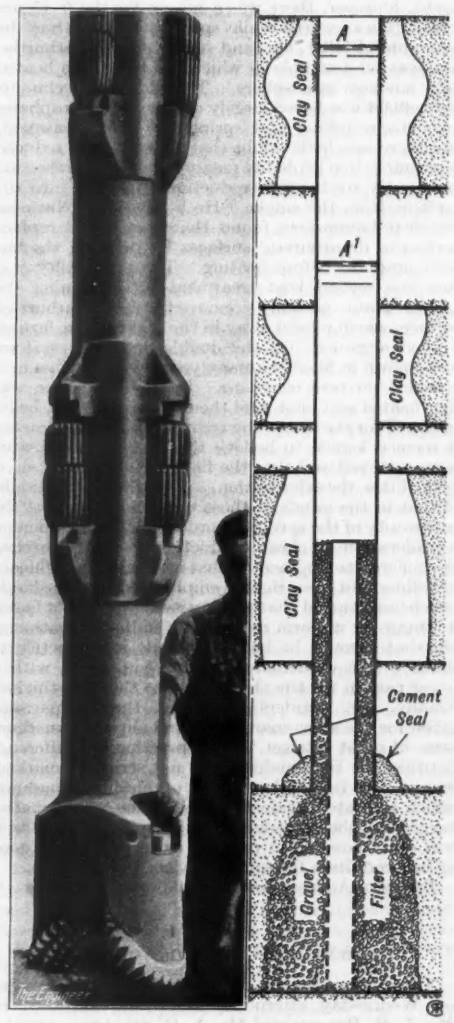
MOST of the people of this country have come, within the last year or so, to appreciate the dependence of modern communities on an adequate supply of domestic water, and to realise the difficulties of meeting those demands as the density of the population increases.

In the Thames Valley—in fact, in most of our English river valleys—there is, year in and year out, an adequate flow of water for the needs of the population if it is properly conserved; but such conservation on an appropriate scale is an expensive matter, as it entails the construction of huge reservoirs, and often the maintenance of large pumping plants, many of which have been described in the columns of THE ENGINEER. There is, however, a vast natural underground storage of water which entails no capital expenditure beyond that of tapping, that has, so far, been only tentatively developed.

This natural reservoir comprises, in the Home Counties, the basin of chalk below London, which is already fairly extensively tapped, and, below that, the greensands. The merit of the chalk lies, of course, in the fact that it is overlaid by the impervious blue London clay, and its outcropping in the hills to the north and the south of the Thames Valley. The result is that the rain falling on the outcrops slowly percolates through the chalk and has saturated it, through ages past, under a hydrostatic head comparable with the height of the outcrops. But the many wells which have been sunk into this chalk formation to provide local supplies of water have so drawn on the reserve that the percolation through the stratum is not able to keep pace with the demand, and the water level is gradually falling. Wells which only a few years ago flowed freely at ground level have now to be pumped, while others, which have always had to be pumped, must be carried down further. In fact, it is beginning to be doubtful if any further drilling into the London chalk for water is advsiable.

In the circumstances, attention is naturally focussed on the greensands below the chalk. This formation also has its outcrops in the high lands at the rim of the valley, and its water is imprisoned under a considerable pressure, while it has the advantage of being comparatively soft, through not being impregnated with chalk. The greensands, however, have disadvantages as a source of water supply on any considerable scale. First, they require a bore-hole considerably deeper than the chalk; secondly, the distribution of the sands is rather erratic; and, finally, the sand, containing, as it does, a proportion of very fine particles, tends to clog up the foot of the well when a flow of water is drawn towards it. All these factors are, of course, appreciated by hydraulic engineers and geologists, but the firm of Howard Farrow, Ltd., of Golders Green-road, London, N.W.11, has decided to adopt the Layne well system of the International Water Company, of New York, with the object of offering to provide supplies of water from the greensand on the principle of "no water, no pay."

The Layne system of drilling for water is a development of the method of searching for oil employed in America, in which the bore-hole is kept full of heavy fluid mud with the object of preventing the inflow of water, oil, or gas until the desired depth has been attained. In the same way, mud is used in Layne wells to form an impervious seal or lining until the proper water-bearing strata is reached. The idea has been utilised extensively in America, and in other parts of the world, including the Sahara, where copious flows have been tapped; and the nearest wells of this type which have been sunk are in Paris. They provide some 20 million gallons of water a day. One of



LAYNE DRILL AND WELL

these wells is about 2726ft. deep by 12in. in diameter, and flows at the surface at the rate of about 42,000 gallons an hour.

These wells are made by a rotary drilling process, using tools of the form shown in our engraving, which represents the 18in. drill used at Paris. The drill is mounted on hollow rods, in this case 6in. in diameter, and is driven at a speed of from 150 to 250 r.p.m. From the start of drilling a pump is used to circulate a thick slurry of clay down the drilling rods and up the annular space between the rods and the bore of the well. This slurry carries with it the *debris* from the drill, which is allowed to settle out in a pond, and the soft mud is returned to the hole. At the same time the pump pressure forces some of the mud into any pervious strata which may be pierced, and seals off those strata, water-tight. At the same time, the weight of the mud prevents the hole from caving in as it progresses. In this way, the well can be drilled to its full depth before it is necessary to put in a permanent lining, or casing, so that in the event of the well proving to be dry, the expense of the trial is reduced to a minimum.

In the case of the Paris well just referred to, the lining was of 12in. internal diameter, and the whole of it was lowered into place in eight hours. At intervals of about 80ft., special seals were formed on the tubing to prevent the liquid clay from flowing down. At the lower end of the casing there was attached a special valve, known as a gravelling valve, and a Layne shutter screen. The work of development was then started. The 6in. drill rods with a 2in. wash line inside were lowered to the bottom of the screen and rested on a special foot valve. Clear water was pumped under a starting pressure of more than 230 lb. through the 2in. pipe, out through the foot valve and between the screen and the sand formation, in through the screen and up through the 6in. drill rods to the surface, carrying with it mud in suspension. This washing pro-

cess was continued until the density, or clay pressure, was approximately equal to the water pressure of the formation. The drill rods were then removed, and a special tee attached to the lower end and lowered into the well again, as far as the graveling valve, which was then connected to the tee. Gravel the size of rice was then injected under high water pressure in the 6in. drill rods through the T and the graveling valve, and into the annular space made by the 18in. drill hole and the 12in. screen and up the 12in. casing. At the same time the rest of the liquid clay inside the 12in. casing was washed out. As and when the clay pressure was reduced to less than the water pressure of the greensand formation, the water started to flow, carrying with it fine sand from this stratum, which was replaced by the gravel pumped in. More than 65 cubic yards of gravel was thus placed around the screen, making a large gravel filter, which filters out the water from the sand and materially reduces the friction loss, thereby increasing the flow from a few cubic metres at the start to 200 cubic metres at the finish. This is, of course, the opposite to what happens with the ordinary wells in greensands where the flow starts with a large production but rapidly decreases on account of sand clogging. Since the clay which seals off the upper porous strata can stand a very high pressure, the top of the casing is connected to a valve which can control the flow and prevent the waste of water without losing any of it through the clay seal into the absorbing formations on its ascension to the surface.

While, as we have said, the possibility of a supply of water from the greensands cannot always be guaranteed, there must be large areas of England where it can be fairly safely assured, and in any case the Farrow contract does not involve the user in fruitless expenditure.

The diagram which we reproduce shows a typical Layne well which may be equipped with a pump, but it is not, of course, always necessary to pump these wells, as they may flow like any other artesian bore.

Progress of a Hydro-Electric Undertaking in New Zealand.

THE Nymboida hydro-electric undertaking was advocated many years ago as a possible source of electric supply for Grafton and the Clarence River district, but it was not until 1918 that any steps were taken towards the development of this undertaking. In 1921 the idea was conceived of carrying out the construction of the works by means of the co-operation of the local government authorities in the district to be served by the undertaking, and to this end the local governing bodies delegated their powers in regard to electricity supply to the Clarence River County Council, which was constituted for this especial purpose. Early in 1923 a contract was entered into by the Council with Sir W. G. Armstrong Whitworth and Co., Ltd., which was entrusted with the work of designing and constructing the hydraulic engineering works, the power station, sub-stations and transmission lines to South Grafton and Ulmarra. At the same time, the County Council undertook the reticulation of the municipalities of Grafton, South Grafton, and Ulmarra with a view to having the latter works completed coincident with an electricity supply being made available from the headworks being constructed by the contractors.

Power is derived from the waters of the Nymboida River, which takes its rise on the Dorrigo plateau, where the average rainfall varies from 60in. to 100in. per annum. Near the township of Nymboida the river has an elevation of approximately 586ft. above sea level, the catchment area of the watershed above the site of the works being approximately 760 square miles. The river is at this point separated from an adjoining valley (locally known as the Goolang Creek, in the watershed of the Orara River) by a low ridge, through which a tunnel had previously been driven by the Grafton and South Grafton Water Board for town water supply purposes. As part of the original installation built in 1924, an overfall weir, 360ft. in length and about 14ft. high, was constructed across the Nymboida River about ¼ mile downstream from this tunnel to provide diurnal storage, and the existing water supply tunnel was enlarged and lined with concrete for the purpose of diverting water for the hydro-electric undertaking. At the outlet of the tunnel a bulkhead was constructed from which a wood stave syphon pipe line, 4420ft. in length and 54in. internal diameter, led to a surge chamber 25ft. in diameter and 25ft. in depth, situated on an eminence overlooking the Goolang Creek. From this surge chamber water was delivered by means of 750ft. of 54in. wood stave and 150ft. of 48in. steel pipe to the power station in the valley below—see Fig. 1—the gross head available from the surge chamber to the tail water in the power station being 220ft. The original power station was built to accommodate three 660 b.h.p. Armstrong-Whitworth water turbines of the Francis type, direct coupled to Crompton Parkinson alternators of 400 kW capacity, but only two of these units were installed at the time the station was put into service, provision being made for the third unit to be installed at a later date. The tunnel and pipe lines, together with the sub-stations and outgoing transmission lines were, however, designed for the full capacity of 1200 kW. Energy, generated at 6600 volts, 50 cycles, and stepped up to 33,000 volts in an outdoor sub-station of 1500 kVA capacity at Nymboida, was transmitted to South Grafton, 23 miles distant, and thence to Ulmarra, a further distance of 8 miles. A sub-station of 1000 kVA capacity was built at South Grafton to serve the needs of South Grafton and Grafton, the Clarence River being crossed by submarine cables, and a sub-station of 250 kVA capacity was constructed at Ulmarra to serve the town. The primary distribution pressure was fixed at 6600 volts in these centres, being stepped down in the distribution sub-stations to 415/240 volts, three-phase supply.

By 1928 over 100 miles of rural transmission lines had been constructed, and the growth of loading both in the urban and rural centres was so rapid that the capacity of the generating plant at the Nymboida power station was being approached. A further extension of the generating plant at Nymboida was accordingly made in 1929, when a 1320 h.p. Boving turbine, direct coupled to a Metro-Vickers alternator of 800 kW capacity, was installed instead of a unit of smaller capacity, as had been originally contemplated. Although the installation of this unit brought the total installed plant capacity of the station to 1600 kW, the effective capacity of the station did not substantially exceed 1200 kW on account of the limitations imposed by the hydraulic capacity of the tunnel and pipe line.

It was in 1930 that requests were received from the Lismore Municipal Council and the Shire of Terania, in the Richmond River District, and also from the Dorrigo Shire, to the south of the Clarence, for power to be made available in these areas; negotiations were also in progress with the Casino Municipality. It had been evident for some time previously that the rapid growth of demand in the Clarence River area would, in any case, necessitate the installation of further generating plant, either by the extension of the power station at Nymboida, or by the construction of a fuel-burning station somewhere in the vicinity of the load centre, namely, Grafton or South Grafton. An investigation of the behaviour of the Nymboida River in past years showed that although the flow of the river was more than sufficient to meet the demands of a generating station up to at least 5000 kW during an average year, there had been in the past at least one exceptionally dry year during which the flow of the river fell far below normal, and, in event of the recurrence of these conditions, the effective capacity of the station would be limited by the river flow to an output not much in excess of 1200 kW. Owing to the steep nature of the catchment area, suitable sites for the storage of any large quantity of water sufficient to provide against water shortage during the driest year that might be expected, were not available, and, in any case, the cost of storage would have been exceptionally high.

The decision was therefore reached to embark upon the extension of the Nymboida power station to provide for an ultimate installed capacity of 4800 kW, the extensions being so designed that the work could be carried out in stages to meet the growing demands of the system, and to construct an auxiliary plant at Lismore. Provision was accordingly made for the construction of a crude oil generating station with an ultimate capacity of 3600 kW. The location of the auxiliary plant at Lismore had further advantages, in that there would always be in this latter station plant of sufficient capacity to meet the needs of the Richmond River district independent of the incoming transmission line.

In October, 1931, the existing crude oil plant then operated by Lismore Municipal Council was taken over by the County Council, and the construction of a new power station was begun at South Lismore. By July, 1932, the building had been completed and a 988 b.h.p., eight-cylinder Davey Paxman crude oil engine, direct coupled to a 650 kW Crompton Parkinson alternator, put to work. The two crude oil generating units of 245 kW and 230 kW capacity, respectively, purchased from the Lismore Council, were then transferred from the old power station to the new building, thus bringing its effective capacity to approximately 1100 kW, which will, before the end of 1934, be increased to 1750 kW, when an English Electric eight-cylinder crude oil generating unit of 650 kW capacity, at present under erection, is put to work.

The extension to the Nymboida power station was put in hand during 1932, and, as it was quite impracticable to enlarge the existing tunnel, a new concrete-lined tunnel, 2200ft. in length and 6ft. 6in. in diameter, was constructed, this tunnel being of sufficient size for the maximum designed output of the station, namely, 4800 kW. Two welded steel pipe lines, each 3800ft. in length and 5ft. in diameter, lead from the outlet of the tunnel to surge chambers constructed adjacent to the original surge chamber, and from this point two welded steel pressure pipes, tapering from 4ft. 6in. in diameter to 4ft. in diameter, running parallel with the original wood-stave pipe line, lead to the power station—Fig. 2—where the three pipe lines are interconnected by 48in. distributing pipes from which water for the turbines is drawn. Although the hydraulic installation has been completed for the full capacity of the station, the building was extended only to an extent sufficient to house two additional 800-kW English Electric turbo-generators, thus bringing the installed capacity of the power station up to 3200 kW. During these extensions the opportunity was taken to redesign and rearrange the switchgear, at the same time making provision for such additional switchgear as will be required at a later date when the station is further extended to its full capacity of 4800 kW.

Although the peak load on the system increased from 400 kW in 1925 to 1805 kW in 1933, the load factor during the same period increased from 28·6 to 48·2 per cent. This increase has been reflected in the cost per unit sold to consumers which has fallen from 3·91d. in 1925 to 2·12d. in 1933, representing a reduction in the cost of electricity to the consumer of 46 per cent. over a period of eight years. The outstanding feature of the Nymboida hydro-electric undertaking is the extent to which supply to rural areas has been developed. The growth of the undertaking in regard to the development of rural electricity supply is well illustrated by the comparison given below between the years 1925 and 1933, in which figures for retail supply are given. These statistics do not include the activities of the two bulk supply consumers, namely, Lismore and Casino Municipalities, in which the nature of the supply is at the present time entirely urban:

	1925.	1929.	1933.
Total number of retail consumers connected to supply	1100	2435	3608
Number of consumers in towns and urban areas	1050	2040	2712
Number of consumers on farms and in rural communities	50	395	896
Length in miles of 33,000-volt and 66,000-volt transmission lines, miles	30	30	167
Length in miles of retail reticulation system	36	109	278
	1925.	**1929.**	**1933.**
Capital cost of reticulation works in towns and rural areas	£25,195	£66,075	£121,586
Revenue derived from the retail supply	£11,332	£27,604	£37,890
Units generated at the power stations	1,012,520	2,552,580	7,626,298
Units sold to the retail consumers	708,949	2,040,114	3,472,206
Units sold to bulk consumers	—	—	2,564,499
Average cost per unit sold retail to the consumer	3·84d.	3·25d.	2·69d.

FIGS. 1 AND 2—THE NYMBOIDA POWER STATION IN 1924 AND IN 1934

TENDERS for the supply of five new regional broadcasting stations, each costing between £150,000 and £200,000, are to be called for by the Australian Government. They will be supplementary to seven other regional stations now in course of construction.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

SOCIAL CREDIT.

Sir,—The discussion of Social Credit is bringing forth the stalwarts (literally) in their columns. First, we have Mr. Vowles, then Mr. King, and now Mr. Gill, like a triumvirate of grotesque figures, such as one might see at a Continental festival towering above the crowds.

And what do they contribute to the problem of the distribution of plenty? Mr. Vowles concludes that a "change of heart" is necessary, and subsequently recommends the study of psychology. Granted that both these things are advantageous to the race, what have they to do with the present problem? In an age of scarcity one can imagine that a change of heart might help in solacing those who must of necessity go short. But to-day with a potential abundance, the suggestion is totally out of place. Imagine the engineers who planned the grid system of electricity distribution. No shortage of the commodity, nor of the physical materials required, nor of the necessary engineering skill and ability. Fancy a philosopher advising them to cultivate a change of heart and study psychology as an aid to the solution of their technical difficulties! The problem is the same exactly, except that instead of stress calculations, loading figures, &c., it is one of production and consumption statistics, and the necessary bookkeeping entries as regards the allotment of tickets. Mr. Vowles "believes the A and B Theorem is demonstrably fallacious." So do a lot of people, but so far none has come forward with a successful "demonstration," and I suggest that a technical paper such as this is just the place for it.

I have dealt already in a previous issue with Mr. King's "co-ordinated demechanisation," and I see that Mr. Gill decides, too, that it is impossible, and, further, that Social Credit "seems the more likely solution." Solution for what? According to the opening of his own letter, "for the financial difficulty of to-day."

And having decided that he goes on to examine the question of leisure, quite a different matter, be it noted, and because he can see no satisfaction for the artistic instinct of the masses in an age when *he* says, "all useful things are made by machinery," he concludes with the remark: "There goes Social Credit."

Why should he postulate that all useful things would be made by machinery? And, by his own opening statement, it was the "financial difficulty of to-day" that was under consideration, not the age of leisure.

Social Credit is an economic theory, and as such has nothing whatever to do with how people might spend their time in an age of leisure. That is a matter for the philosopher, the moralist, the educational pioneer.

Let us stick to the facts. There is potential abundance for all to-day; thousands are lamentably poor; how can they get money to acquire the abundance? Major Douglas' theory shows this to be impossible through the wage system, and suggests that it must be augmented with National Dividends. Engineers go on perfecting the machinery of production; it is time they turned their attention to the machinery of consumption, and allowed no one to lead them down any by-paths.

C. W. Ryden.

Glasgow, May 6th.

Sir,—The case of demechanisation *v.* Social Credit is ably summed up by Mr. Eric Gill in your issue of May 3rd, but with the experience of the past twenty years before me, I, for one, cannot admit that this civilisation will go the way of others. Surely a nation like ours can solve the simple problem of whether we master finance or whether finance masters us.

There is no doubt, as Mr. Vowles says, that Douglas Social Credit circles contain their quota of the failings found in every society or organisation, and, as there is nothing new under the sun, it is inevitable that some of Douglas's ideas have been thought of before. We may yet find bricks in Ur of the Chaldees, inscribed with the A+B theorem.

Nevertheless, Douglas does deserve to rank among the great ones of history, if only for the fact that he has consecrated the last eighteen years to preaching certain doctrines until they have taken root. Mr. Vowles states that the A+B theorem is demonstrably false. I should like to see its falsity demonstrated, in simple language, understandable of the multitude.

The failure of inventors, prophets, and some preachers is that they see so clearly themselves that they fail to realise that others do not, and they are liable to lapse into pseudo technical phrases which either put the listener off, or make him feel that it is only one more variation of "that sweet word Mesopotamia." In his previous letter, Mr. Vowles was on very sure ground when he mentioned religion, and the fact that in some Social Credit circles it is considered *vieux jeu*.

My opinion, coming from one careless in these matters, is that we shall continue to wallow in the sea of troubles in which we find ourselves, until the Churches take hold and, without mentioning, let alone recommending, remedies, say to us—a condition of affairs where, through lack of the necessities of life, malnutrition, starvation and suicide, can exist hand in hand with open and unashamed restriction of production and destruction of surpluses, with a view to raising prices, is inherently evil, and we refuse to tolerate it. See to it that it ceases. I had hoped to see opinions passed on my suggestion that in view of their responsibilities in the matter it is the duty of engineers, through their societies, to debate the question. I agree that it comes somewhat outside the normal type of discussion, but the gravity of the problem overrides this. In the words of his Majesty "It cannot be beyond the power of man so to use the vast resources of the world as to ensure the material progress of civilisation. No diminution in these resources has taken place. On the contrary, discovery, invention, and organisation have multiplied these possibilities to such an extent that abundance of production has itself created new problems."

Not so many years ago piano legs, to say nothing of those belonging to members of a certain sex, were decently draped and were not talked about. The author of "The Golden Bough" could probably explain the origin of that particular taboo and could tell us why mankind, having lifted it, promptly created another perfectly good one to take its place in the existing monetary system. It is rather a reflection on science that in certain directions we are still under the spell of the witch doctor.

K. W. Willans.

London, May 7th.

THE SOUTHERN RAILWAY AND TOWN PLANNING.

Sir,—May I suggest that it is perhaps unnecessary to drive the Southern Railway underground and that a possible solution of the Charing Cross Bridge problem is to extend Victoria Station and to divert all Charing Cross traffic thereto? An examination of the suburban connections concerned of this railway will show that it would not be a difficult matter, and in spite of the cost of widening the track and extending the terminal station, it might be far the cheapest as well as the quickest method.

Saffron Walden, May 3rd. J. G. B. Sams.

RAILWAY SPEEDS.

Sir,—Speeds of express passenger trains have recently been very much in the news as a consequence of the London and North-Eastern Railway's tests of steam locomotive performance in comparison with Diesel-engined vehicles in German service, and if we believe all we read it would appear that the express services throughout the country are about to receive a drastic speeding-up. Increased speed on the railways is very desirable, provided that the usual standards of safety are maintained, but to improve the rate of travel of one particular section of general traffic without similarly dealing with the remainder would appear to be a difficult task indeed. Railway traffic consists of a series of services run under "passenger" or "freight" conditions, the former (excepting a few special cases) varying in overall average speeds from 20 to 60 m.p.h. and the latter from the crawl of the "pick-up" goods train, held back to give preference to every other train and saddled with the shunting of the wayside yards, to the comparatively high speed of the continuously braked express train running at anything up to 45 m.p.h. or thereabouts; a cursory examination of the train diagram referring to any busy line will show how neatly the various classes of trains have to be fitted in.

In the event of any material speeding-up of the express service it would therefore follow that the remaining services would require similar adjustment in order to clear the road, a comparatively easy matter in connection with trains run under passenger conditions, but a little more difficult as regards the freight service generally. Passenger train rolling stock is reasonably close coupled and invariably fitted with the continuous brake, and if the usual class of locomotive cannot rise to higher speed it is always possible to replace it with one of greater power or to halve the train and run a relief service. The freight rolling stock is largely without continuous brakes or close couplings and a necessary preliminary to speed in freight service is their provision. The question of increased power is not difficult, as it is always possible, if the approximate limit of power in connection with the heavier freight trains has been reached, to obtain a considerable increase by articulating the locomotive; such a step would allow an ample margin for speeding-up without reduction of load. The provision of continuous brakes raises a further difficulty: which of the two systems in general use in this country is to be adopted? Current practice indicates that compressed air is the preferable medium for quick-working passenger services, but that the vacuum brake is standard on all steam-operated passenger services over main and country lines, as well as on the regrettably small proportion of freight trains utilising the continuous brake. Such trains are usually limited in load on account of their speed and in consequence the vacuum system functions satisfactorily, but it is questionable whether it would survive the couplings of a sixty-five-wagon train, which is no more than a normal haul; given that it is possible to create a certain amount of vacuum in the sixty-fifth wagon and brake van in rear, it would be of small barometric pressure and would occupy several minutes in creation. On these grounds, therefore, it would appear that compressed air was the better braking medium, although more expensive in first cost and maintenance; it is submitted that the efficient braking of long freight trains is a necessity to the rapid handling of general traffic.

The successful use of a continuous brake requires reasonably taut couplings between the vehicles of a train if rebounds are to be avoided; it is practically impossible to make an emergency stop with the continuous brake without creating a tendency to rebound somewhere in a slack-coupled train, and there is no doubt that the life of the couplings is adversely affected thereby. The standard three-link coupling of the freight rolling stock cannot, therefore, be termed satisfactory. The existing alternative is the screw coupling, but a certain amount of time is required for its adjustment or disconnection and the presence of the shunter between the vehicles is involved—an undesirable and sometimes dangerous proceeding. The correct alternative is the combined central coupling and buffer, as it is instantaneous in action and free of danger to staff in addition to absence of slack. The conversion of the entire rolling stock in this country to a new system of coupling is a question of the utmost magnitude, but at the same time it is not an impossibility, and observing the cost of unemployment, especially in the engineering industry, it is submitted that a preferable course would be the financing of the railways in order that productive employment might be found in effecting this very necessary step.

April 27th. J. G. B. Sams.

SIXTY YEARS AGO.

On Saturday, May 8th, 1875, there took place the long-expected trial trip of the steamship "Bessemer." A representative of this journal attended and described his experiences in our succeeding issue. The vessel was remarkable for more than the swinging saloon with which Sir Henry, or Mr. Bessemer as he then was, proposed to eliminate the distressing effects of a Channel crossing. In the first place she was of unusual size as cross-Channel steamers went in those days. She had a length of 350ft. and over the paddle-boxes a width of 65ft. Her main deck was 270ft. long with a beam of 40ft. Forward and aft, or rather at each end for she was double-ended, the main deck ended in a peak or bow and standing at this point the passenger looked down on a lower deck carrying capstans and anchor gear. These lower decks had a very low freeboard, so low in fact that on the trial trip there were many occasions on which they were submerged to a depth of 2ft. by the bow wave pouring over them. They were not intended to be habitable but were designed to assist the fore and aft stability of the ship. Two entirely independent pairs of paddle wheels driven by two separate engines propelled the ship. Longitudinally between the paddles the hull accommodated the famous swinging saloon. This saloon consisted of a room 70ft. long, 30ft. wide and 20ft. high. It weighed between 170 and 200 tons and was mounted on a pair of fore and aft trunnions. Its motion about these trunnions was counteracted by hydraulic machinery under the manual control of a sailor. On its top the saloon was formed as a passenger deck. The engines of 4000 h.p. were situated in two separate engine-rooms about 100ft. apart and were supplied with steam by eight boilers. The paddle wheels were 30ft. in diameter. Hydraulic power was used not only for controlling the motion of the saloon but also for reversing the engines, for steering the ship, and for operating the capstans. The saloon was however the dominating feature of the ship. It and it alone was Bessemer's contribution to the vessel the general design of the ship being Mr. E. J. Reed's. The ship was built round the saloon so much so that everything had to be made subservient to it. It was very heavy and consequently the engines had to be made unduly light as compensation. Even so the draught of the vessel as finished was nearer 9ft. than the originally intended 7ft. 6in. On the trial trip the weather was disappointingly calm and the saloon was not operated. It was admitted by Mr. Bessemer that the operating gear was not all that it might have been and that, in any event, the man charged with its control had, so far, had little or no opportunity of familiarising himself with it. The basis of operation depended upon the observation of a spirit level. Although it is not mentioned in our article we know that Bessemer at one time intended to use a gyroscope as a means of obtaining automatic control. The fundamental error in his gyroscopic device was pointed out to him by Macfarlane Grey who patented a correct application but a difference of opinion arose between the two men and Bessemer eventually gave up the idea of using automatic control. On the trial trip while the ship was entering Calais harbour the current and wind caught her at one end and swung her round against the jetty. In a few seconds about 50 yards of the jetty were demolished. A second mishap of the same kind occurred on a succeeding trip. The bill for damages submitted by the French authorities led to the end of the company organised to build and operate the vessel.

CANADIAN HARBOUR IMPROVEMENTS.

The Canadian Government has voted a sum of 3,500,000 dollars to be spent on the deepening of the Montreal Harbour and improvements to the port itself. The programme provides for the completion of the construction of a portion of Laurier Pier to a low level on the downstream face, and a portion of the outer end for a total length of about 750ft. The construction of this pier was undertaken some years ago, about two-thirds of it being completed to a depth of 35ft. Other items in the programme are the reconstruction of the Sutherland pier in such a manner as to provide for the deepening of the adjoining berths to a depth of 35ft. at low level; the reconstruction and raising to a high level of shore wharves for a distance of about 1500ft.; the reconstruction of a portion of the wharf of about 500ft.; the extension of the marine jetty to improve the equipment at elevator No. 3 to permit the unloading of grain from ocean vessels; the reconstruction of Windmill Point wharf for a distance of about 1488 lineal feet. These are the principal works other than the deepening of the harbour itself. This problem of low water levels has been discussed for some years, and has been the subject of representations to the Government by the Shipping Federation of Canada, the Montreal Board of Trade, and the Montreal Chamber of Commerce. No definite details have been given as to how the Government proposes to maintain a greater depth throughout the harbour, especially in the upper section where practically all the larger ocean liners now have their terminals, but it is expected this information will be divulged in the very near future.

Rail and Road.

THE Automobile Association has been given permission by the main line companies to fix on the gates of public road level crossings reflex signs, consisting of three small round red reflectors, and three small round white reflectors.

THE position of assistant signal engineer, Great Western Railway, to which, as related herein on April 12th, Mr. H. F. D. Page has been promoted as from May 1st, had previously been filled by Mr. S. Hutt, who had been in the G.W.R. signal department for forty-five years. Mr. Hutt retired on April 30th.

THIS centenary year of the authorisation of the Great Western Railway sees also the one hundredth anniversary—on May 5th—of the first issue of the *Railway Magazine*, which, six years later, passed to the control of Mr. Herapath. In 1837 the *Railway Times* was founded, and, some years afterwards, the latter absorbed *Herapath's Railway Journal*, and in 1914 it was itself taken over by the *Railway Gazette*.

THE Transport Committee of the Manchester Corporation recently approved the recommendation of Mr. Pilcher, the transport manager, that trams should gradually be replaced by buses. There are 402 buses belonging to the Corporation and 678 trams. Whilst the former are 39 per cent. of the total number of vehicles, they contribute 44 per cent. of the total revenue, and carry 6040 passengers weekly, as against 5720 on the trams.

THE Board of Trade export tables for March show that during the first three months of the present year there was a gratifying increase when compared with the corresponding period of 1934 in the value of the railway material shipped overseas. The figures, with the corresponding sums for 1934 in parentheses, are as follows:—Locomotives, £227,360 (£86,355); carriages and wagons, £247,257 (£171,140); rails, £189,462 (£118,460); wheels, steel sleepers, fishplates, and miscellaneous materials, £299,333 (£174,685).

AN interesting feature of the Southern Company's further electrification is to be found at the east end of Lewes Station, where the railway crosses the river Ouse by a bridge that has a lifting span in the middle in order to permit masted vessels to pass. As a consequence of this interference the high-tension cables could not be carried along the bridge and they have, therefore, been laid in concrete pipes placed 3ft. below the river bed. The river was dammed as required, the water pumped out, and a trench dug for the pipes.

THE Ministry of Transport railway statistics for January last show that, compared with the corresponding month of 1934, the number of passenger journeys increased by 2·5 per cent. and the receipts from passengers by 2·7 per cent. There was, however, a decrease of 0·3 per cent. in the tonnage of freight and of 1·8 per cent. in the receipts from freight train traffic. The freight train mileage rose by 0·2 per cent.; the average train load decreased from 129½ to 125¼ tons, but the net ton-miles per engine hour increased from 451¾ to 453¾.

A POINT in which the general public in London is closely concerned was recently decided in the Ilford County Court. It was to the effect that the London Passenger Transport Board is a public authority, not run for profit, and therefore under the Public Authorities Protection Act an action for compensation for personal injuries must be commenced within six months of the date of the accident. In the case in question a passenger fell down the stairs of an omnibus, due to the fault of the driver, but judgment was given for the L.P.T.B. on the grounds stated.

THE "Twentieth Century Limited" of the New York Central Railroad and the "Broadway Limited" of the Pennsylvania used to cover the 960 miles of the former—over an easier road—and the 902 miles of the latter between New York and Chicago in eighteen hours. By agreement between the two companies the time was, some years ago, extended to twenty-four hours, ostensibly on the grounds of safety, but actually to cut out an unprofitable extra expense. The New York correspondent of *The Times* now reports that after reverting some time ago to the eighteen hours' timing the journey was reduced on April 28th to seventeen hours. This, we presume, is a response to the higher speeds that have been developed on a few roads in America, as in this country, in France and Germany.

ON April 28th Mr. Leonard Archbutt died in his seventy-seventh year. He was for forty-two years the chief chemist of the Midland Railway and retired, on reaching the age limit, in April, 1923. Mr. Archbutt contributed nearly thirty papers, chiefly on analytical chemistry, to various scientific journals, and one of these, in collaboration with Mr. R. M. Deeley, the Midland locomotive superintendent, appeared in THE ENGINEER of June 27th and July 11th, 1896, on "The Thermo-dynamics of the Vacuum Brake." This, as a contemporary remarked, "proved on scientific grounds and by experiments in the laboratory and on trains, that the charges brought against the brake at that time of being liable to become frozen up in winter time and rendered inoperative through the deposition of atmospheric moisture in the brake pipes, were groundless." Messrs. Archbutt and Deeley were also the joint inventors of the water-softening process that bore their names.

THE Union of South Africa Railways' report for the year ended March 31st, 1934, contains an item which has reminded us of what Mr. E. J. H. Lemon said at the last annual dinner of the Permanent Way Institute, as recorded herein on February 15th, advising the use of a ciné-camera for watching details of permanent way work. Mr. Watermeyer, we find, says that there are many problems connected with track maintenance that a high-speed camera would elucidate, *e.g.*, the behaviour of a rail joint during the passage of a locomotive and the motion of a railway vehicle round a curve. An ultra high-speed motion picture camera, capable of taking up to 2500 photographs in a second and simultaneously recording time in one-thousandths of a second has therefore been purchased. Standard 16 mm. ciné films, in 50ft. and 100ft. spools, will be used, and a standard 16 mm. ciné projector completes the equipment. A portable petrol-electric generator will supply the necessary power to operate the camera and thus enable the apparatus to be used in isolated places where there is no main power supply.

Miscellanea.

A SYSTEMATIC search for oil deposits is to be made throughout Germany with the idea of making the country independent of foreign supplies.

WE learn that Mr. F. W. Gaskin, A.M. Inst. C.E., M.I. Water E., has been elected President for the sixty-second Session of the Liverpool Engineering Society.

TESTS made by an American firm making lead titanate indicate that increased durability, better gloss retention, less cracking and flaking is obtainable in paints and enamels made with lead titanate.

TWO more telephonic districts in Paris have gone over to the automatic system. Of the total of 209,000 telephone subscribers in the Metropolis, 199,000, or 95 per cent., are now connected to automatic exchanges. It still remains to transform the Central Exchange, which serves the City area.

CONSTRUCTION has been started of a new hydro-electric station in the U.S.S.R. at Perm, in the Urals, which is to have a capacity of 360,000 kilowatts. A sum of 60 million roubles has been allotted for the purpose. A number of auxiliary enterprises will be built, including a lumber mill, lime and alabaster plants, and machine shops.

WHEN, shortly after the French Revolution, says Arthur D. Little, Inc., Cambridge, Mass., a Parisian was asked "What did you do during the Reign of Terror?" he replied, "I survived." We, likewise, are content that our *Bulletin* has similarly survived the "Coolidge Prosperity," the "Hoover Depression," and the "Roosevelt Recovery." Survival, in these times, is synonymous with success.

SELENIUM compounds, says the *Industrial Bulletin*, taken internally or absorbed through the skin, cause the whole body to take on a most vile and offensive odour, suggesting horseradish, garlic and brass all at once. It takes real courage for chemists who realise the possibilities to work with the selenites and selenates, for a single familiarity may scent one's perspiration and breath for a month. The skunk might have a research job done by the chemist, using selenium, to increase his "Schreck-lichkeit."

FIRE-RESISTANT cellulose acetate sheets of medium flexibility can be made from solutions in a volatile solvent in which 20 per cent. or more of triphenyl phosphate based on the cellulose acetate weight is dissolved, states an extract in the *Chemical Trade Journal*. Fire-resistant compositions of medium flexibility can be produced by dissolving cellulose acetate of the proper acetyl content and viscosity in a hot mixture of triphenyl phosphate and methyl phthalyl ethyl glycollate. Increasing the proportions of methyl phthalyl ethyl glycollate improves the flexibility at the expense of fire resistance. The fire resistance can be increased by incorporating non-combustible fillers which have been ground in methyl phthalyl ethyl glycollate. Flexibility, gloss, adhesion, and stability are increased by the addition of small amounts of toluene sulphonamid-formaldehyde resins.

A PROCESS is being developed in Sweden whereby arsenic is utilised in the cements being used for the protection of wooden piles used for piers and harbour works. The admixture of arsenic with the cement helps the cement to adhere to the wood and at the same time confers a certain degree of elasticity, so that the cement coating does not easily peel off. In the operation of the method, twelve parts of sand, three parts of cement, and a quantity of white arsenic are mixed dry in a concrete mixer. The dry powder is blown through a hose to the place where the piles are to be treated, mixed with water, and immediately blown on the piles from a double nozzle. The coating dries in about 15 min., and is said to be sufficiently tough and strong to permit handling the piles without injury to the coating. Most of the work is done from a barge to prevent spreading the poison, and the men at work are provided with masks and gloves as a protection from the arsenic in the spray.

THE theories which seem to apply to the deposition of the more noble metals from aqueous solutions do not apply in general to the base metals. Selecting the electro-deposition of chromium as a typical case, numerous experiments were carried out under widely different conditions, and the results are published in a paper given before the American Electrochemical Society by Mr. R. R. Rogers. The results support the conclusions:—(1) That the film of electrolyte in intimate contact with the cathode is more alkaline than the main body of the bath; (2) that this film must have a definite pH value for metal deposition to take place; (3) that the final reduction of chromium to the metallic state is due to atomic hydrogen and not to a mere electron exchange between cathode and positively charged metal ions; (4) that the amount of atomic hydrogen available at the cathode must be maintained within well-defined limits. Evidence is presented in support of the theory that even the most active metals may be electro-deposited from aqueous solutions.

A PLAN for rebuilding the famous Brooklyn Bridge in New York by retaining the present anchorages, towers and main cables, and suspending therefrom new stiffening trusses and a new floor fabricated from structural aluminium shapes and plates, which has been developed and proposed to the city by D. B. Steinman, consulting engineer, and by the Aluminium Company of America, is described in a recent issue of *Engineering News-Record*. The new design eliminates the diagonal stays of the old bridge, and incorporates details that bring the structure up to modern standards. At an estimated cost of 6,250,000 dollars, with 2,000,000 dollars additional for approaches, the proposed plan of reconstruction will provide twelve 10ft. lanes for vehicular traffic on two decks. The present cross section of the bridge accommodates on one deck two rapid-transit tracks, two street car tracks, and two vehicle lanes. The new design is based on unrestricted use of vehicles up to 25-ton trucks, while at present all commercial traffic, with the exception of mail trucks, is barred from the bridge. By using aluminium the total dead load on the bridge will not be increased.

Air and Water.

THE Italian Navy is reported to have ordered a small destroyer propelled by heavy oil engines.

THE proposed international air race round South America has been postponed until the spring of 1936.

THE German battleship "Bayern," salved at Scapa Flow last September, has been towed to Rosyth for breaking up.

THE aircraft carrier H.M.S. "Courageous" is to carry out a series of tests with an autogiro to ascertain its suitability for naval work.

IN future all vessels engaged in the Holland-Africa express service to South Africa will call at Southampton on their outward and homeward voyages.

IT has been officially announced by the Parliamentary Secretary to the Irish Free State Department of Finance that plans for a civil airport for Dublin are under consideration.

THE Dutch Air Lines announce that they will shortly open up a new air route linking Holland, Scotland, and Iceland. The new route is to be the first section of a Trans-atlantic air line from Europe to America, *viâ* Greenland.

TWENTY-THREE new aerodromes and seaplane bases are to be opened in France during the next twelve months. Of these, three will be State landing grounds, fourteen aero club grounds, and six will be private grounds open to public traffic.

A TWO-ENGINED Douglas monoplane has established an American transcontinental record in flying non-stop from Los Angeles to New York, 2400 miles, in 11 hours 5 min. The machine was controlled for a greater part of the distance by an automatic gyro pilot.

FOLLOWING the successful completion of an official fifty hours' bench test, the "Bristol" Mercury VI engine is now officially approved for use with the Hamilton controllable pitch airscrew, which has been standardised for use with 1935 "Bristol" engines. In addition to the official endurance test, a fifty hours' flying test has been successfully completed by a Mercury VI engine installed in a "Bristol" Bulldog.

A NOTE in *Flight* recalls another jubilee which has to a large extent been overlooked. Twenty-five years ago, on April 23rd, 1910, Claude Grahame-White and Louis Paulhan, piloting Henry Farman aeroplanes, fought a stirring battle for £10,000 offered by the *Daily Mail* for a London-Manchester flight. The winner, Paulhan, took roughly twelve hours for the flight. To-day the regular commercial schedule calls for a 1½-hour trip, including one stop.

ON Saturday, May 4th, the Cunard White Star motor ship "Georgic" began her first westbound voyage from Southampton to New York under the company's new arrangement whereby she and her sister ship, the "Britannic," will be operated from the Channel ports instead of from Liverpool. The "Georgic" and "Britannic" will make London their terminal, but will utilise Southampton as a port of call for passenger embarkation and disembarkation.

ARRANGEMENTS have now been completed by the new French company, Air Bleu, for a service of internal air mails which will begin to operate on May 15th, when the first two routes, Paris–Arras–Lille and Paris–Tours–Poitiers–Angoulemè–Bordeaux, will be opened for traffic. On June 1st the Paris–Toulouse service will come into operation, to be followed on July 1st by a service from Paris to Le Havre and Strasbourg, and on July 30th by the last of the projected services, Paris–Nantes.

ACCORDING to Herr Essberger, the Director of German Shipping, German shipping is in a worse position than a year ago. Speaking at a recent meeting, he said that the German shipbuilding yards were at present fairly well occupied, but the work was almost exclusively for foreign account. There were very few German owners in a position to order new shipping, and those only did so because they had had to sell their old tonnage. Consequently, the tonnage was being paid for "out of substance," and German shipping would decrease more and more in importance.

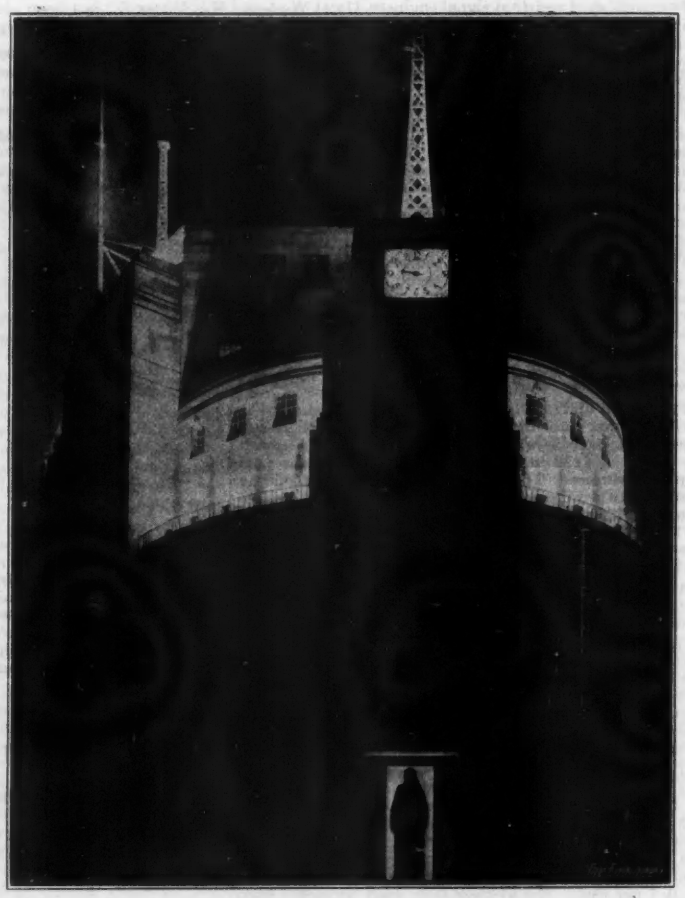
FOR the purpose of operating air services in West Africa, Elder Dempster Lines, Ltd., and Imperial Airways are forming a joint company, to be known as Elders-Colonial Airways. Imperial Airways are also making arrangements to open a service from Khartoum to Nigeria, which will provide a through connection from London to Lagos, *viâ* Khartoum, El Fasher, Fort Lamy, Maidugari, Kano, Kaduna, and Illorin. Elders Colonial Airways will operate an extension from this service to Accra and to Kumasi and Takoradi as soon as suitable ground organisation is provided at these places. It is hoped later on to provide a service to Freetown.

A STATE Department announcement made in the United States says that the United States and Great Britain have entered into an agreement to simplify aeronautical flights between certain of their respective territories. The territories included in the agreement are:—On the American side: the United States Continent, American Samoa, the Panama Canal zone, Puerto Rico, and the Virgin Islands; on the British side: Great Britain, Northern Ireland, Newfoundland, Labrador, the Bahama Islands, Barbadoes, Bermuda, British Guiana, British Honduras, Jamaica, the Leeward Islands, Trinidad, Tobago, and the Windward Islands.

THE Argentine National Congress is being asked to sanction the expenditure during the next five years of over twenty million paper pesos on the purchase of new dredgers and dredging material. Much of the equipment operated by the Ministry of Public Works in keeping clear the access to the country's many ports is out of date, and for some time past it has been recognised that overseas shipping was unduly handicapped by the want of sufficient depth of water in many of the canals giving entrance to docks in different zones of the country. As customary, public tenders will be called for, as soon as the project becomes law, and the necessary specifications can be drawn up.

FLOODLIGHTING FOR THE JUBILEE

(For description see page 494.)



ABOVE:—ST. PAULS, LONDON
BELOW:—THE CATHEDRAL, BIRMINGHAM

ABOVE:—BROADCASTING HOUSE, LONDON
BELOW:—HAMPTON COURT PALACE

The Engineer

MAY 10, 1935.

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Contents.

THE ENGINEER, May 10th, 1935. PAGE

A SEVEN-DAY JOURNAL ... 479
THE HUME DAM ON THE MURRAY RIVER. (Illus.) ... 481
THE IRON AND STEEL INSTITUTE ... 482
THE ROYAL SOCIETY'S CONVERSAZIONE ... 485
TORQUE CONVERTERS: INSTITUTION OF MECHANICAL ENGINEERS 486
WATER FROM THE GREENSANDS. (Illus.) ... 486
PROGRESS OF A HYDRO-ELECTRIC UNDERTAKING IN NEW ZEALAND. (Illus.) ... 487
LETTERS TO THE EDITOR—
Social Credit—The Southern Railway and Town Planning—Railway Speeds ... 488
SIXTY YEARS AGO ... 488
CANADIAN HARBOUR IMPROVEMENTS ... 488
RAIL AND ROAD ... 489
AIR AND WATER ... 489
MISCELLANEA ... 489
LEADING ARTICLES—
The Anglo-Continental Steel Pact ... 491
London's Sewage ... 491
ALLOYS—OLD AND NEW ... 492
JUBILEE FLOODLIGHTING. (Illus.) ... 494
VOITH TURBO TRANSMISSIONS. (Illus.) ... 494
LOCOMOTIVE ROD BORING AND TREPANNING MACHINE. (Illus.) 495
ATOMIC ARRANGEMENT IN METALS AND ALLOYS ... 495
WORM GEARED MOTOR UNITS ... 496
SOUTH AFRICAN ENGINEERING NOTES ... 496
GREATER LONDON DRAINAGE ... 497
MARKETS, NOTES AND NEWS ... 499
CURRENT PRICES FOR METALS AND FUELS ... 500
FRENCH ENGINEERING NOTES ... 501
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 501
FORTHCOMING ENGAGEMENTS ... 502
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 502
CONTRACTS AND ORDERS ... 502
LAUNCHES AND TRIAL TRIPS ... 502

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THE ANGLO-CONTINENTAL STEEL PACT.

THE first stage of the long-drawn-out bargaining between the British and Continental steel makers has ended in an arrangement which should afford both parties a moderate amount of satisfaction. Some amongst the British steel makers will regard the establishment of a Continental quota for the British market of 643,000 tons with mixed feelings, whilst the Continental makers may compare that quantity with the 2,000,000 tons of pre-duty days and sigh for markets irretrievably lost. The progress of the negotiations reflected feelings akin to these. At first it seemed that neither the British nor the Continental works were over-anxious to enter into an arrangement, but the British Government had other views and used its influence to make the steel makers negotiate an agreement covering first the home and secondly the export markets. The Government probably had in mind the desirability of increasing employment at home and strengthening the trade balance with overseas countries. Only the initial stage has been reached by the agreement arrived at in London on April 30th. For a trial period of three months the imports of Continental steel are to be limited to 160,750 tons, which is at the rate of 643,000 tons per annum. At a previous meeting in London the Cartel had refused to accept this tonnage and had demanded 900,000 tons. Later, at a meeting at Cannes, little progress was made, but on the return of the British delegates the duties were suddenly increased from 33⅓ per cent. to 50 to 60 per cent. This action took the Continent by surprise and evoked complaints that the Cannes meeting had left the Continental steel makers under the impression that the duties would not be raised pending further discussions. A meeting at Brussels followed, at which the British are stated to have offered a quota of 270,000 tons, consisting almost entirely of semi-finished steel. To this the Continent replied with an offer of 643,000 tons with a reduction in the duties to the 33⅓ per cent. level, acceptance or rejection being required by April 30th. A further meeting was held in London on that date and the proposal was accepted. Negotiations for an arrangement covering the export markets are to be conducted during the trial period, and the Government has reduced the duties as from May 8th. In addition to the quota, 9500 tons of wire bars are to be admitted for the British wire trade.

The quota of 643,000 tons per annum which the Continent has accepted is the same as the British imports of steel from Cartel countries in 1933, and the total will be divided into proportions of finished and semi-finished steel in the same ratio as in that year. It represents a considerable reduction from the 912,000 tons imported from Cartel countries in 1934, and whilst that should benefit the British steel makers it may entail some hardship upon the consumers of Continental material in this country. The Import Duties Advisory Committee has laid it down that the advantages to the country outweigh any "transient disadvantages to small sections of the industry and that on a long view this policy will best serve the interests of these sections." The increase of employment resulting from the manufacture of so much more steel in the country has been estimated at 40,000, and although this figure may have been based on a much smaller Continental quota, it will be interesting to watch the actual effects of the arrangement. The Import Duties Advisory Committee has stated that the satisfactory results it anticipates are dependent upon the general price policy to be pursued by the British industry; but there seems to be some expectation that the Continental steel makers, now that they are assured of a quota, will raise their prices to obtain compensation for the curtailment of their sales in Great Britain by several thousand tons. That, however, may prove less easy than appears on the surface. Apart from the bulk tonnages taken by re-rollers, a large quantity of Continental steel has been bought hitherto by stockholding merchants for re-sale in small quantities to consumers. It is obvious that there must be a substantial difference between the Continental and British prices to allow the stockholder to handle the foreign steel in that way. The problem which will face the Cartel, therefore, will be how to raise prices without further reducing its sales in this country. At present the agreement amounts to a permission to the Continental steel makers to sell a given tonnage in the British market; but to make full use of that privilege they may find it necessary to continue to sell as cheaply as hitherto. In other respects the arrangement may bear less hardly upon the consuming industries than was feared at one time. Most users of Continental steel will be relieved by the abandonment of the suggestion that the imports should be bought and re-sold by the British Iron and Steel Federation. Besides being a direct attack upon the distributing branches of the trade, such an arrangement would have been bitterly resented by consumers, large and small.

Agreement of even a tentative character regarding the British market has been reached with great difficulty, and the Committees negotiating an arrangement providing quotas for the British and Continental steel makers in the export markets may well have undertaken a still more strenuous task. The claims of both sides to many overseas markets are well founded and will not be lightly surrendered. The susceptibilities of the countries which are the subject of the negotiations will have to be taken into consideration, or consequences unpleasant to both the British steel makers and the Cartel may ensue. There has been a tendency in the past for this aspect of the problem to be treated somewhat carelessly; but the Cartel at any rate has learned by experience that foreign buyers are not altogether defenceless against the operations of great combines. The treatment of Empire markets, also, cannot be settled over the heads of Canadian, Australian, South African, and Indian manufacturers and buyers. It may be assumed that the British manufacturers will follow their usual policy and endeavour to retain the Empire markets for themselves. Those markets will not be readily ceded, since in spite of heavy adverse duties, some of them take considerable quantities of foreign steel and will not be relinquished without a struggle. For instance, it is known that the Cartel will not lightly surrender its share in the Indian trade—but can a deal be made without bringing in the Indian steel industry as a third party to the discussions? These are only a few of the problems to be considered, and they illustrate the difficulties in the way of making a comprehensive Anglo-Continental arrangement. The advantages of an export agreement are obvious, but it is equally apparent that unwelcome sacrifices will have to be made and that compensation for lost tonnages can only be sought by charging higher prices.

London's Sewage.

THE draining of London and the disposal of its sewage constitute a public service, perhaps, more important than any other, for upon its proper functioning depends directly the health of every inhabitant. Besides dealing with storm water, the sewers of London must carry away each of those 40 gallons per head per day supplied by the Metropolitan Water Board, and dispose of them in such a way that no nuisance shall be caused. As the number of inhabitants of the area grows, the problem confronting those concerned with the disposal of sewage becomes increasingly difficult of solution. For, while the amount of sewage to be dealt with increases, the expansion of built-up areas sends up land values and makes both more difficult and more expensive the acquisition of land of a suitable nature for the extension of disposal works. The natural drainage channel for London is the river, and for a period during the last century, at the time when the then existing system of cesspool drainage was being suppressed, it was, in the words of an angry Member of Parliament, "one vast sewer, which would surely spread disease and death around." In fact, being tidal to a point far within the boundaries of the city, the river is totally unfitted for use as a sewage disposal channel, and consequent upon the frequent complaints that were made the present system of intercepting sewers with outfalls at Beckton and Crossness was constructed to serve the inner area. Districts growing up outside this area have largely been forced to fend for themselves in the construction of independent disposal works.

London still continues to grow, and as a result of certain recommendations of a Royal Commission on the Local Government of Greater London, contained in a report issued in 1923, the London County Council approached the Ministry of Health to see what action, if any, should be taken. As a result, the L.C.C. consented to its Chief Engineer, then Sir George Humphreys, being associated with an Inspector, Mr. J. R. Taylor, appointed by the Ministry to investigate the question of the drainage of London and the adjacent areas. On the retirement of Sir George Humphreys from his post as Chief Engineer in 1930, he retained his connection with the inquiry with which his successor, Mr. T. Peirson Frank, also became associated. These three gentlemen have now issued a report of their findings, of which excerpts are given on another page. The area examined covers 1928 square miles, lying approximately within a radius of 25 miles from Charing Cross, and containing, besides the 159 square miles under the control of the London County Council or other authorities making use of the same disposal works, 1769 square miles outside the London County system. In the latter area it was found that there is on the average one sewage disposal works in every 9½ square miles, and that examples of almost every known form of disposal are to be found. This condition is regarded as unsatisfactory, and it is suggested in the report that, subject to financial considerations, the fewer the number of works, the greater would be the benefit to the community generally. A scheme is therefore put forward by the carrying out of which in three stages, the number of works would be reduced to about ten, at an estimated cost of £50,000,000. The possibility of building a great trunk sewer and discharging into the sea at Dungeness on the south coast was also examined, and estimated to cost in the neighbourhood of £110,000,000. There can be little question that the expenditure of such great sums of money is at present not essential. The schemes are designed, it would seem, to meet the probability of a future great expansion of the number of inhabitants of the area under consideration. Whether it is, in fact, desirable that one or both of the schemes should be carried out, either in the near future or after a greater span of time, obviously depends very much upon what the rate of growth of London is likely to be. If within forty years the population of Greater London is likely to approach 15 million persons, as estimated as a possibility in the report, then an expenditure of £50 million may not be regarded as excessive when it is remembered that the number of potential nuisance centres will be much reduced; that authorities will be relieved of the difficulties of obtaining sites for new disposal works, and that the amenities of several districts will be improved.

Whilst, then, there can be no question that a very useful purpose has been served by the inquiry, it is undoubtedly necessary that the real need for any such costly system of "rationalisation" should be very carefully examined. The expenditure envisaged by the report appears to be very greatly in excess of any amount that has before been expended in the London district in connection with the disposal of sewage and can only be justified by a large increase of population. But the prediction of such an increase over a period even as short as four decades is very uncertain, and the results of the calculation must be accepted with the more reserve in that 15 millions is equal to

nearly one-third of the population of the British Isles, in which little further increase can be expected. Moreover, the proposals are open to the suspicion that they own kinship with several similar "rationalisation" schemes, such as the water grid and the electrification of railways, from which the advantages to be gained seem hardly worth the cost. It is at least possible that the gradual construction of such systems as that now being built in West Middlesex will do, in proportion as the population increases, all that the signatories to this report envisage, without the risk connected with the larger conception that provision may be made for conditions that may never in fact arise. The issue of the report is, however, but a preliminary. Its opinions are based upon no detailed surveys and merely direct attention to possible methods of dealing with the problems involved. Much water will have to pass through the sewers of London before the Ministry of Health comes to any conclusions as to whether the schemes are to be adopted or not, and before that time, we hope, all those interested will have been given an opportunity to state their views.

Alloys—Old and New.*

By Sir H. C. H. CARPENTER, D.Sc., F.R.S.

The Study of Alloys.

ALTHOUGH many carefully planned and accurately executed investigations have been performed on alloys, the subject as a whole cannot be said to have been systematically studied. This is no reflection on those who have taken part in this study, for it could not, under any circumstances, have followed a pre-ordained programme. To begin such a systematic study pure metals would be required in the first place. Then from these, binary, ternary, and more complex alloys would have to be made and studied with full knowledge of the effects of casting conditions, working, thermal treatment, &c. Actually, alloys have been made and studied by using impure metals and in ignorance of some of the effects of casting conditions, heat and mechanical treatment. While the study of these has been going on other investigations have been pursued in order to discover how to eliminate impurities so that in the future purer alloys may be made and studied. Then from other investigations experience has been gained that has increased our knowledge about casting, working, thermal treatment, and methods used in studying properties. This has been utilised in later investigations either on the same or different alloys. From time to time phenomena have been discovered which have caused an intensive application of research on particular lines, and it has been shown that work previously done in ignorance of these phenomena cannot be regarded as reliable. Considered as a whole, the study of alloys has followed a very devious route, but it has always proceeded in the same general direction, viz., towards a fuller comprehension of the subject and an ability to produce a greater variety of useful and reliable alloys.

At the present time our knowledge is founded on what may be described as the characteristic nature of each individual alloy in the condition in which it will be used. To this we relate its properties on the one hand, and its previous treatment on the other. This nature is determined first of all by its composition. What are the properties of the basis metal or metals? What are the effects of the subsidiary elements present as impurities or added by design? Next comes the question of constitution. What sort of crystals are formed by the atoms of the elements present? Are all the added elements in solid solution in the basis metal, and what effect do they have on its properties? Are other constituents formed; if so, of what kind are they, and what are their properties? A third important factor is structure, *i.e.*, the arrangement of the crystals of the constituents in the solid alloy, and the fourth is condition, in which may be included the effects of cold working, inclusions, forging defects, quenching cracks, and casting defects, such as blow-holes, contraction cavities, hot-tears, &c.

The characteristic nature of the alloy as it goes into service is the basis of our study. We consider its previous treatment and its behaviour in use in relation to this, and thereby achieve a more accurate correlation between treatment and properties than would be possible if these had to be directly connected. When we know that a certain result may be obtained by a particular sequence of treatments, we utilise this knowledge, but we are not satisfied until we know why this sequence gives that particular result. We are then in a position to modify this treatment so as to secure even better results, and, furthermore, we can often produce other alloys that will be improved by similar treatments.

The Composition of Alloys.

The study of alloys would be greatly simplified if it were possible to consider separately each of the factors that constitute its nature in relation to each stage in its treatment and each of its properties. Actually, however, nature, treatment, and properties are so intimately connected that they must be considered together. Thus, although various headings may be selected to facilitate description, it is impossible to adhere strictly to this plan.

When composition is considered alone without regard to treatment, its importance is seen to vary greatly with the properties we have in mind. In the case of electrical conductivity, composition is all-important, and in preparing conductivity copper or aluminium the highest attainable purity is sought. Where it is technically impossible to eliminate all the impurities, and there is some choice as to which impurity should be left, constitution is important, because elements that do not enter into solid solution have less effect in decreasing the conductivity than those that do. Thus, in the manufacture of high-conductivity copper, the object is to eliminate other impurities by means of oxygen while leaving as little of this element as possible in the metal. If mechanical strength has to be taken into account in addition to conductivity, other aspects of the composition become important, and so does treatment. Considerable improvement in strength may be effected by cold working without serious diminution of the conductivity of copper or aluminium, but when further increase in strength is necessary recourse must be had to some other element that raises the strength as much as possible while decreasing the conductivity to a minimum extent. Thus silicon or cadmium is added to copper to increase its strength in the cold-worked condition, and silicon, magnesium, and manganese are added to aluminium to increase its strength in the heat-treated condition.

For magnetic properties, also, composition is a most important factor, but treatment as affecting condition and constitution must also be considered. When high magnetic permeability is required, selection is restricted to iron in the purest condition available, an iron alloy containing about 4 per cent. of silicon, and iron-nickel alloys containing about 50 or 70 per cent. of nickel. The permeability of all these metals is best when they are free from the effects of cold working, and when they have been given the correct heat treatment, which consists of annealing the first two and of cooling the iron-nickel alloys at a controlled rate. Despite the effect of treatment, however, the composition is the controlling factor. When high remanent magnetism and high coercive force are required, quite different alloys are used, and treatment becomes of even greater importance. The properties of the original carbon magnet steels depend just as much on the fact that they are quenched so as to retain them in the martensitic condition as on their high carbon content. Similarly, with the tungsten, chromium, and cobalt steels subsequently introduced, heat treatment is important because of its effect on constitution, and although treatment is not so essential in developing the properties of the newer iron-nickel-aluminium magnet alloys, it has, nevertheless, an important influence.

Chemical properties as exhibited by resistance to electro-chemical corrosion and direct oxidation also depend primarily on composition. These influence many uses of metals, for whenever a metal is employed without a surface coating of some other metal, some compound, paint or enamel, it may be said to be thus employed because it resists satisfactorily the conditions to which it is exposed. The environments in which metals are used are very varied, and a large number of them may be said to give satisfactory service in one way or another. The metals, however, in which resistance to oxidation and corrosion are important properties are in general those that are used where others would fail. Some of the metals used in this way are pure metals, *e.g.*, lead, copper, nickel, or aluminium, while others are alloys that owe their high corrosion resistance to the presence of certain elements.

Although numerous metals are used under conditions where some resistance to corrosion is required, the number of alloys that are specifically employed because of this property is not large. The basis metals of these alloys are iron, copper, and nickel, and the added elements are nickel, chromium, aluminium, silicon, and tin. As these owe their resistance to corrosion to their capacity to form continuous adherent protective films, and confer this property on the metals to which they are added, their effect depends on their form of occurrence. The second metal must always be held in solid solution by the first. The heat and corrosion-resisting non-ferrous alloys, *e.g.*, aluminium-bronze, aluminium-brass, nickel-copper alloys, nickel-chromium alloys, and nickel-chromium-iron alloys are all solid solutions, while in ferrous alloys it is only that proportion of the protective element that is dissolved in the iron that is effective.

As chromium and iron form a continuous series of solid solutions, all the chromium would be available to protect the iron if no carbon was present. But when it is present, carbides of high chromium content are formed, and the corrosion resistance of the alloy is appreciably decreased if these are permitted to separate from solution. Thus constitution has a pronounced effect on the resistance of such steels, and must be carefully controlled. There are four general types of these steels—the pearlitic, martensitic, austenitic, and ferritic. Of these the first, which is represented by stainless iron, may be regarded as an attempt to combine a fairly high resistance to corrosion with properties similar to those of high-tensile structural steels. It may be used in the annealed, normalised, or quenched and tempered condition, and although the carbon, and therefore some of the chromium, is not retained in solid solution in some of the conditions of its use, sufficient chromium remains dissolved to impart a moderately high resistance to corrosion. In the martensitic type both carbon and chromium are retained in solution by heating to a temperature sufficiently high to dissolve the carbide, quenching as rapidly as possible, and tempering at a temperature below that at which carbide begins to form. If the quenching temperature is lowered the rate of cooling decreased, or the tempering temperature raised, some chromium carbide is formed, less chromium remains to protect the iron, and the corrosion resistance is diminished.

The other two types of stainless steel are conspicuously different from steels in general, in that they do not undergo the ordinary reversible changes on heating and cooling, and do not respond to treatments like normalising, hardening, and tempering. Austenitic steels were used before austenitic stainless steel was developed. Thus Hadfield's manganese steel proved invaluable for numerous purposes, because of the toughness of the austenite retained by quenching, and its tendency to transform to hard martensite on any surface subjected to wear and abrasion. Austenitic nickel steel was used because of its non-magnetic and corrosion-resisting properties. Nevertheless, the introduction of the austenitic nickel-chromium steels represents a new development in steel metallurgy, because of their high resistance to corrosion, suitability for hot and cold working, and insusceptibility to heat treatment in the usual sense. The ferritic stainless steels were the first steels of this type to be used.

The austenitic stainless steels illustrate some interesting aspects of the relations between composition, treatment, constitution, and properties. Nickel is one of the elements that increase the range of stability of austenite, and about 28 per cent. is required to retain this constituent down to atmospheric temperatures. Chromium, however, is one of the elements that decrease the range of stability of austenite, and in the absence of carbon and nickel no austenite is formed in iron-chromium alloys containing more than 14 per cent. of chromium. Yet when this element is added along with nickel it supplements its effect in retaining austenite down to atmospheric temperatures, and the best-known types of such steels contain chromium and nickel in the proportions 18/8, 15/11, and 20/7. The constitutional effect of chromium in these cases does not depend on its influence on the relations between γ and α iron under equilibrium conditions. It rests on its action in retarding transformations. An alloy containing 18 per cent. of chromium, 8 per cent. of nickel, and 74 per cent. of iron solidifies as a mixture of ferrite and austenite. During cooling the ferrite changes to austenite above 1300 deg. Cent., in the same way that δ changes to γ iron in iron-carbon alloys. Under equilibrium conditions ferrite should begin to re-form at 850 deg. Cent. and continue to below 300 deg. Cent., when the alloy would consist mainly of this constituent. But at ordinary rates of cooling from 900 deg. to 500 deg. Cent., ferrite does not form at all, and the sluggishness of the alloy prevents it from forming at lower temperatures. Thus, although chromium decreases the range of stability of austenite under equilibrium conditions, in nickel-chromium steels of suitable nickel content it promotes the retention of austenite at atmospheric temperature by inhibiting the changes that should take place on cooling below 850 deg. Cent.

The solubility of carbon in the nickel-chromium austenite of stainless steels is very small. According to Aborn and Bain, it decreases from 0·4 per cent. at 1200 deg. Cent. to 0·03 per cent. at 800 deg. Cent., and becomes less than this at lower temperatures. The actual carbon content of these steels is generally below 0·1 per cent., but it is never below 0·03 per cent., and consequently, under equilibrium conditions, a carbide phase should be present below 800 deg. Cent. Under ordinary conditions of cooling, however, the formation of carbide in the range 800–400 deg. Cent. is prevented, and it cannot take place below this temperature. Thus the carbon is retained in solid solution and assists in stabilising the austenite. But in operations that involve heating at temperatures above 450 deg. Cent. diffusion of carbon can proceed at an appreciable rate, and any carbon in excess may separate from solution and form

* Iron and Steel Institute. Presidential Address, May, 1935. —Abridged.

carbide. This contains a considerable amount of chromium, and as the rate of its diffusion is much slower than that of carbon, the carbide is formed from chromium drawn from the vicinity of the crystal boundaries. The chromium content is thus decreased and corrosion is liable to occur there. It is on this that the intergranular corrosion of stainless steels depends. The technique of controlling or preventing it has since been developed.

It is evident from the foregoing that the corrosion resistance of stainless steels depends (1) on the presence of chromium, (2) on this element being dissolved in the iron, and (3) on the presence of a minimum amount of carbide. Their mechanical properties depend, however, on their constitution rather than their composition, and pearlitic, martensitic, austenitic, and ferritic chromium or nickel-chromium steels resemble other steels of similar constitution more than they resemble each other.

Constitution and Structure.

Equilibrium Diagrams.—Whereas the nature of the electrical, magnetic, or chemical properties required practically determines the composition of the alloy to be used, when mechanical properties only have to be considered there is usually a choice of several alloys which will give the required results.

The study of the constitution and structure of alloys is based on their equilibrium diagrams, and, neglecting changes in the solid state, most of the diagrams that apply to the useful ranges of composition of industrial binary alloys may be classified as follows :—

(1) Each metal is soluble in the other to a limited extent when solid, and alloys of intermediate composition consist of a mixture of these two solid solutions. Examples of this type are the lead-antimony, lead-tin, and nickel-chromium systems. The aluminium-silicon system must also be included in this class, although there is no solid solubility of aluminium in silicon.

(2) The two metals are soluble in each other in all proportions when solid. The copper-nickel, iron-chromium, and iron-vanadium alloys are examples of this type, but the iron-nickel, iron-cobalt, and iron-manganese alloys may also be included, although the crystal structure of the solid solution changes with the composition. The two face-centred cubic metals copper and nickel form a continuous series of solid solutions with face-centred cubic lattices. The body-centred metals chromium and vanadium form a continuous series of solid solutions with body-centred iron, but when the face-centred metals nickel and cobalt are alloyed with iron, solid solutions with a body-centred lattice are formed at the iron end, while throughout the rest of the system face-centred solid solutions are produced. In the iron-manganese system, however, in addition to the body-centred solid solution formed at the iron end, and the face-centred solid solution at higher manganese contents, there is a third solid solution formed when the manganese exceeds 70 per cent., viz., one based on the tetragonal lattice of γ manganese. In these systems of alloys between iron and nickel, cobalt and manganese, respectively, solid solutions based on α iron, γ iron, and the other metal occur, but as the lattices of nickel and cobalt are the same as that of γ iron there are only two different solid solutions, whereas owing to the difference between γ iron and γ manganese there are three different constituents in that system.

(3) At the useful end of the system the added element is soluble to some extent in the basis metal, and when this limit is exceeded a eutectic between the solid solution and an intermediate constituent appears. Examples of this type are the alloys of iron with carbon, molybdenum, tungsten, and silicon and those of aluminium with copper, iron, manganese, and magnesium.

(4) A series of intermediate constituents is formed as in the alloys of copper with aluminium, zinc, tin, and silicon or in those of iron with aluminium.

Constituents of Alloys.—When one solid metal dissolves another a primary solid solution is formed, whose characteristic feature is that the atoms of the solute metal are incorporated in the lattice of the solvent metal. Two different types are recognised. Most primary solid solutions are of the substitutional type, *i.e.*, atoms of the solute are substituted for those of the solvent metal. Thus in the primary solid solutions formed by copper and nickel, nickel atoms are substituted for copper atoms in the copper lattice, and as the nickel content increases the proportion of copper atoms in the lattice decreases until it consists entirely of nickel atoms. A few primary solid solutions are of the interstitial type, in which the atoms of the solute take up positions in the interstices of the solvent lattice. The best known example of this type is the solid solution of carbon in γ iron, but it appears that interstitial primary solid solutions are generally formed when transition elements like titanium, vanadium, chromium, manganese, or iron dissolve elements with small atoms like hydrogen, carbon, and nitrogen.

In systems of the first and second types mentioned above only primary solid solutions are formed, but in those of the third and fourth types intermediate constituents also occur. The principal characteristic of the latter is that their crystal structure is different from that of either of the metals composing them. What may be described as the basic lattices of these constituents contain the two kinds of atoms in definite proportions, but the composition of a given constituent may vary by the substitution of atoms of one kind for those of the other. Thus the β constituent in copper-zinc alloys is based on a lattice containing an equal proportion of copper and zinc atoms, but its composition may vary by the substitution of copper for zinc or zinc for copper atoms.

In the numerous alloy systems that have been studied, a very large number of intermediate constituents have been recognised. In general their basic lattice contains the two metals in definite proportions, which can be represented by a formula. Metallurgists have always divided these constituents into two classes, namely, solid solutions and intermetallic compounds, and Hume-Rothery, in order to distinguish solid solutions of this type from primary solid solutions, has proposed to call them secondary solid solutions. It is, however, difficult to decide whether there is a difference in kind or only in degree between intermetallic compounds and secondary solid solutions. The intermediate constituents may be divided into two classes, in one of which we may place those that have crystal structures and other properties similar to the pure metals and a moderately wide composition range of stability, while in the other class we may place those that have crystal structures and other properties different from pure metals and a narrow range of stability. We may call the former secondary solid solutions and the latter intermetallic compounds, but we cannot be sure that the difference implied by these terms is a real one, and not just a division into two arbitrary groups of a gradually varying series of constituents. At the present time it is possible either to regard all the intermediate constituents as compounds because they may be represented by a formula, or to regard none of them as compounds because the existence of different atomic linkages in different metallic constituents has not yet been proved, or to classify them into groups on the basis of composition range of stability, mechanical properties, melting point, and the relations between their crystal structure and that of the pure metals.

The original classification of alloy constituents is further complicated by the knowledge that has been acquired in the study of the distribution of different kinds of atoms in crystal lattices. In most of the intermediate constituents the two kinds of atoms are disposed in an orderly manner on a common space lattice, so that if all the atoms of either kind could be removed without displacing the others these would still be arranged in a regular pattern. In most primary solid solutions the two kinds of atoms are arranged in a disorderly manner on the common space lattice, so that if all the atoms of either kind could be removed without displacing the others, these would not form a regular pattern in space. In certain intermediate constituents, however, *e.g.*, the β phase in the copper-tin system, there is no order in the disposition of the two kinds of atoms, in certain others, *e.g.*, the β phase in the copper-zinc system, a change from a disordered to an ordered arrangement takes place, and the same kind of change also takes place in several primary solid solutions, *e.g.*, iron-aluminium, copper-gold, and probably iron-nickel, and iron-vanadium. As the development of a perfectly ordered arrangement of two kinds of atoms in a given space lattice requires their presence in definite proportions, these symmetrical lattices formed from primary solid solutions can be represented by formulæ, *e.g.*, Fe_2Al, FeAl, Cu_2Au, and FeV.

Following on the concepts originally advanced by Hume-Rothery, it has been shown that the formation of many intermediate constituents requires a certain ratio between the number of atoms and the number of valency electrons. Thus in the six alloy systems containing copper, silver, and gold on the one hand, and zinc and cadmium on the other, the basic lattices of the β phases have formulæ of the form CuZn, and the ratio of valency electrons is 3 to 2, while the γ phases have formulæ of the form Cu_5Zn_8, and the ratio of valency electrons to atoms is 21 to 13. In the copper-tin system the formula of the β phase is Cu_5Sn, which gives a ratio of 3 electrons to 2 atoms, while that of the δ phase is $Cu_{31}Sn_8$, which gives a ratio of 21 electrons to 13 atoms. The same rule applies to the β and δ constituents in the copper-aluminium system, which have the formulæ Cu_3Al and Cu_9Al_4. The phases based on the compositions NiAl, CoAl, MnAl, and FeAl all have the same space lattice as CuZn. Aluminium has 3 valency electrons, and therefore if the ratio of 3 electrons to 2 atoms applies to these constituents it must be assumed that the transition elements do not contribute any valency electrons to the crystal structure. If the valency of such elements in phases of this kind can be assumed to be zero, the compositions at which phases with the γ brass structure should appear may be calculated. As this contains valency electrons and atoms in the ratio of 21 to 13, it should appear in phases containing the compositions Fe_5Zn_{21}, Co_5Zn_{21}, Ni_5Zn_{21}, &c. Westgren has shown that this expectation is realised.

It is evident from the above that there is a general similarity in crystal structure between constituents that differ considerably in their properties and conditions of formation, *e.g.*, FeAl, Cu_3Al, and NiAl, and at the present time it is difficult to reconcile the classification of constituents on a basis of crystal structure with one on the basis of properties and conditions of formation. It is wisest at present to describe as intermediate constituents all those phases that are not primary solid solutions.

Structure.—Cast solid-solution alloys have a well-known cored structure, but the extent to which the composition varies within the individual crystal depends on the distance between the liquidus and solidus. Thus coring is pronounced in copper-nickel alloys near the middle of the system, and in α brass, but is less pronounced in copper-aluminium alloys. Working and annealing eliminate the cored structure, and a system of uniform polyhedral crystals is produced. After this treatment the mechanical properties depend on the composition of the solid solution and the size of the crystals. Cold working deforms the crystals and increases the strength of the alloy. In many alloys this may be further increased by low-temperature annealing after working, *e.g.*, in steel and nickel-copper alloys, but if the temperature is high enough the effect of cold working disappears, and the mechanical properties then depend on the crystal size established in the annealed metal.

In systems of the second type mentioned above, only solid-solution crystals are formed. In those of the first and third types a eutectic appears when the limit of solubility of the added element in the basis metal is exceeded. This forms a matrix in which primary crystals of the solid solution are embedded, and if its properties are very different from those of the solid solution there is a marked change in them when it appears. This is most clearly shown in iron-carbon alloys, for whereas those that contain no eutectic can be forged with ease, those containing eutectic can only be forged with great difficulty, if at all. The same applies to aluminium-copper alloys, which are unsuitable for working when the copper exceeds 5 per cent. In both systems the sudden change in working properties that accompanies the appearance of the eutectic is due to the brittle nature of the new constituent that occurs in it. It is also due, however, to its distribution, and in aluminium-silicon alloys in which silicon occurs in the eutectic, the working properties are not seriously affected, because the silicon is present as discontinuous particles in a soft matrix.

When an alloy consists of a fairly ductile constituent in a matrix of a brittle eutectic, working tends to break up the brittle and establish continuity of the ductile constituent, and if this can be done without fracturing the metal, subsequent working may be carried out with comparative ease. Thus iron-carbon alloys containing the austenite-cementite eutectic may be worked to a certain extent if the amount of the eutectic is not too great and sufficient care is exercised in the early stages. Similarly, aluminium-copper alloys containing up to 10 per cent. of copper have been hot rolled experimentally, and finally high-speed steel, which solidifies as crystals of austenite surrounded by a network of austenite-carbide eutectic is forgeable if care is taken in the early stages when the network is being broken up.

In systems of the fourth type various changes occur in the solid state, and consequently the structures that exist at atmospheric temperature are different from those formed on solidification. Alloys of copper with silicon, or of iron with aluminium, in which the proportions of silicon or aluminium exceed the amount soluble in the primary α solid solution, are not used. The useful alloys of copper and tin solidify as α or as $\alpha+\beta$, while those of copper with zinc or aluminium solidify as α, $\alpha+\beta$ or β. In the copper-zinc and copper-tin systems the β formed at solidification does not occur in a eutectic with α, whereas in the copper-aluminium system such a eutectic is formed. In the copper-zinc and copper-aluminium systems alloys that solidify as $\alpha+\beta$ change to α during subsequent cooling. In copper-aluminium and copper-tin alloys β undergoes a eutectoid change. Thus, at atmospheric temperatures, the copper-zinc alloys consist of α, $\alpha+\beta$ or β, and the α in the $\alpha+\beta$ alloys is formed from β by a change in the solid. The copper-tin alloys consist of α or $\alpha+(\alpha+\delta)$ eutectoid, the latter being formed from β produced at solidification. The copper-aluminium alloys consist of α or $\alpha+(\alpha+\delta)$ eutectoid, and when a structure of the latter type exists it is all formed from β.

Conclusion.

To sum up, composition is the first factor to be considered in connection with the properties of an alloy. All properties depend on this to a greater or less extent, but other factors—constitution, structure, and condition—are also important. The composition is fixed when the alloy is cast, while the other factors are influenced by the casting technique, and the heat and mechanical treatment of the solid metal. Most of the alloys used in the cast condition contain a eutectic, *e.g.*, the cast irons, aluminium-coppers, and aluminium-silicons. Bronze contains a eutectoid, while brass consists of solid solutions. Most of the alloys used in the worked condition solidify as solid solutions, *e.g.*, steel, brass, copper-nickel, and the heat-treatable alloys of aluminium. Finally, most of the alloys subjected to heat treatment solidify as solid solutions and undergo subsequent changes in the solid, *e.g.*, steel and the heat-treatable light alloys.

Heat treatment consists of controlled heating and cooling operations designed to modify the properties of an alloy by promoting or preventing constitutional and structural changes. But these are also influenced by the presence of elements other than those required, which have to be reckoned with. Steel is the outstanding example of an alloy in which the mechanical properties depend on constitution and structure, and the control of these by heating and cooling and by the addition of other elements. The heat-treatable alloys of aluminium fall into the same category as do the more recently developed heat-treatable alloys of copper and nickel. Certain elements facilitate the retention of the soft condition by quenching, others promote the necessary precipitation hardening during the cooling of a chill casting or a hot stamping, others accelerate or retard precipitation hardening at atmospheric or elevated temperatures, while others may be used to raise the recrystallisation temperature so that the hardening due to cold working and precipitation may be simultaneously utilised.

Jubilee Floodlighting.

THE examples of Jubilee floodlighting illustrated on page 490 give a good idea of the results that can be obtained with modern electrical illuminating equipments. The floodlighting scheme for St. Paul's which was designed jointly by the G.E.C. and Siemens, presented unusual difficulties. Owing to the size of the Cathedral, it soon became apparent that any attempt to floodlight the whole building would be impossible except at prohibitive cost, and it was therefore decided to confine the lighting to the Dome from the main colonnade upwards. To make the most of the architectural features of the colonnade and the stone gallery upon it, and at the same time to reduce the halo of light which is liable to occur on misty nights when floodlighting is carried out from a distance, batteries of 1000-watt floodlighting projectors were placed between and behind the columns of the colonnade and behind the balustrade of the gallery. In conjunction with the local lighting on these two galleries, the Ball and Cross and the tower supporting them have been illuminated with narrow-beam floodlights placed far out at the east and west corners of the roof. Altogether, ninety-three floodlights have been employed, sixty-nine on the colonnade and stone gallery, and twenty-four lighting up the Ball and Cross. The cost of the installation was met by public funds raised through the medium of H.M.O.W., and the equipment was installed by G. E. Taylor and Co., and the Johnson and Murrell Electric Company, Ltd.

The old mellow red brickwork of Hampton Court called for special treatment. By floodlighting the building with Osira red floodlights a remarkably good effect has been secured. Six red Osira floodlights have been installed in the moat on either side of the main gateway, and a battery of three floodlights up the back of the first court-yard, thus giving a very attractive impression of depth and an excellent view through the main archway. The south front facing the river has been similarly treated with twelve red floodlights, while four units of different colours play on the fountain in the central avenue. The complete picture sections of the gardens adjoining the barge walk are illuminated with local floodlights in contrast with the main lighting behind. The installation was presented and installed by the London and Home Counties Joint Electricity Authority.

Owing to its construction only the upper portion of the white stone building forming Broadcasting House could be dealt with, but by reason of its height and the fact that this portion of the building can be viewed from a distance, very satisfactory results have been secured. On the eighth floor on the recessed Portland-place side of the building, fourteen floodlights, with 500-watt Osram lamps arranged at maximum projection, are concealed by the existing flower boxes, while on either side five 150-watt floodlights illuminate the lower stone-work and give a varying intensity. This effect is repeated on the two side portions of the ninth floor which are recessed still further. The fifth and sixth floors at the corner of the building are illuminated by 500-watt floodlights, and the statue over the main entrance is silhouetted, the effect being completed by the brilliant floodlighting of the three pylons erected on the roof. The electrical contractors in this case were Troughton and Young, Ltd.

The illumination of the Birmingham Cathedral, shown on page 490, has been carried out by nineteen floodlight projectors, each containing 1000-watt lamps. The whole of the tower and front of the building is floodlighted, the City of Birmingham Electricity Supply Department being responsible for the installation.

JUNIOR INSTITUTION OF ENGINEERS.—On Friday, May 3rd a most enjoyable dinner took place at the Hotel Metropole London. This was the annual dinner of the Junior Institution of Engineers. The post of honorary toast master was taken by one of the Vice-Presidents, Mr. W. A. Tookey, who invested this usually solemn and formal office with a humour which certainly added to the enjoyment of the proceedings. Armed with a symbolical spanner, with which to call for order, his introductions gave the cue to the speakers and maintained a level of fun in the entire proceedings. After the loyal toasts had been honoured, further toasts were "The Institution," "Electrical Engineering," "Our Guests," and "The Chairman." The Mayor of Westminster, as the Institution's principal guest, had asked to be excused from replying to the toast of "Our Guests," having a further engagement for the latter part of the evening. An acceleration of the programme enabled him to make a most witty response. His thanks were seconded by the President of the Institution of Electrical Engineers, Dr. W. N. Thornton, and by Mr. W. E. Highfield, a Vice-President of the same Institution. Dr. Thornton admitted to some trepidation as to whether he was expected to speak "in parallel," with Mr. Highfield; but his fears were set at rest by Mr. Tookey. A variety entertainment added to the amusement of the evening.

Voith Turbo Transmissions.*

By DR.-ING. WILHELM HAHN.†

THE fundamental difference between a hydraulic coupling and a torque converter is that in the former the impeller and runner work directly together without the interposition of a guide wheel or reaction member. The sum of the torques acting on any system must be equal to zero. Therefore, in order to obtain a difference between the torques at the input and output sides, so as to effect a torque conversion, the torque converter requires some stationary part to take up this difference. If M_1 is the input torque, M_2 the output torque, and M_3 the torque with which the flow is deflected in the guide wheel, then

$$M_2 = M_1 \pm M_3.$$

The sign of M_3 is positive in the case of a torque increase and negative in case of a torque decrease on the secondary side.

Fig. 1 shows the flow in a torque converter working on

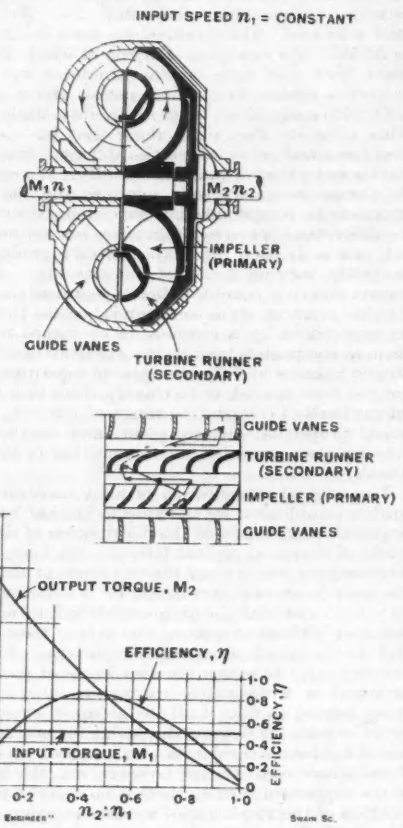


FIG. 1—*Flow in Föttinger Torque Converter.*

the Föttinger principle. The working liquid flows from the stationary guide vanes into the primary wheel or impeller. There it is accelerated and the pressure increased. It passes directly into the secondary wheel, or turbine runner. Here the working fluid passes its kinetic energy on to the shaft and then again enters the guide wheel at a corresponding angle. The deflection of the absolute flow in each of the three wheels determines the torque reaction in any particular wheel.

In a torque converter the relation between power, torque, and number of revolutions is given by $N = C_1 n^3$, where N is the power, n the rotational speed, and C_1 a constant. The torque $M = C_2 n^2$, where C_2 is a constant. The efficiency $= \frac{M_2 n_2}{M_1 n_1}$, where M_1 and n_1 represent the torque and speed at the input shaft, and M_2 and n_2 the corresponding values at the output shaft.

The extent to which the diameter influences the output of a converter may be determined from the expression $N = K n^3 D^5$; thus the power which can be transmitted increases as the fifth power of the diameter.

In Fig. 1 the relations between M_1, M_2, and η of a torque converter are shown as functions of the speed of the output shaft, *i.e.*, of the ratio n_2/n_1, under the supposition that the primary speed n_1 remains constant. According to the choice of blading for the primary impeller, the secondary turbine, and the guide wheel, different characteristics of the torques M_1 and M_2 can be obtained.

If the full power output of the motor is always to be

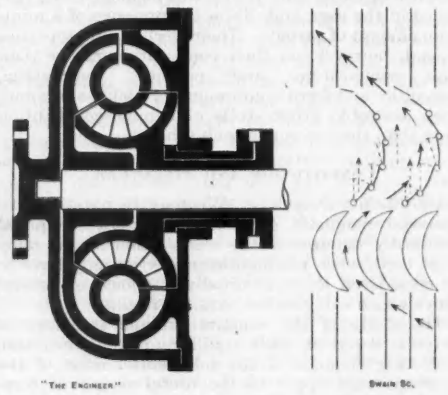
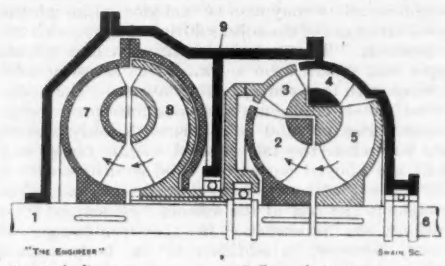


FIG. 2—*Flow in Vickers-Coats Torque Converter.*

used for torque conversion, then, for a constant motor speed n_1, the primary torque M_1 of the converter, must also remain constant, independent of the speed of the output shaft, as shown in the diagram. This can be best attained by arranging the guide wheel directly before the primary impeller.

The torque conversion itself, *i.e.*, the ratio M_2/M_1, is determined by the blading of the primary (impeller) and secondary (turbine) wheels. From the impeller the power is transmitted to the turbine by the liquid circulating under a certain pressure or head. The greater the pressure created by the impeller for a certain output, the smaller



1 Input shaft.
2 Turbo converter impeller (primary).
3 First stage.
4 Stationary guide vanes.
5 Second stage.
6 Output shaft.
7 Turbo coupling impeller.
8 Turbo coupling runner.
9 Fixed casing.

FIG. 3—*Voith Turbo Transmission.*

will be the quantity of liquid necessary for the given power transmission. On the other hand, the amount of liquid required is greater in inverse ratio to the value of the selected pressure created by the impeller. The pressure, the quantity of liquid, and the shape of blading together determine the character of the curve of the torque M_2. By a suitable selection of these values the starting torque can be influenced, *i.e.*, the secondary torque M_2 for the stalled condition where $n_2/n_1 = 0$. The greater the amount of circulating liquid becomes in proportion to the head, the more favourable the starting torque will be. Thus it happens that for equal pressures in the primary impeller the secondary torque can be increased by employing a two-stage converter on the secondary side; on the other hand, the same starting torque can be attained with a single-stage converter by a corresponding pressure decrease. While the increase in the quantity of the circulating liquid gives more favourable starting conditions, the efficiency for the given dimensions of a converter is unfavourably

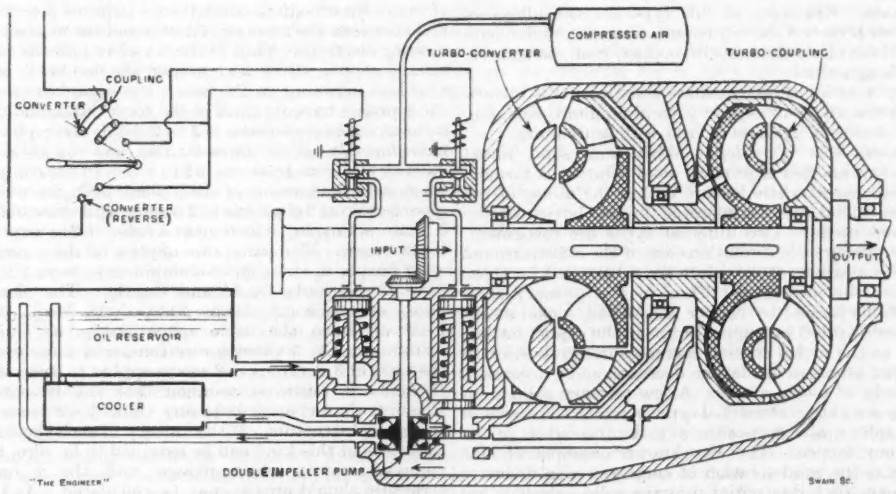


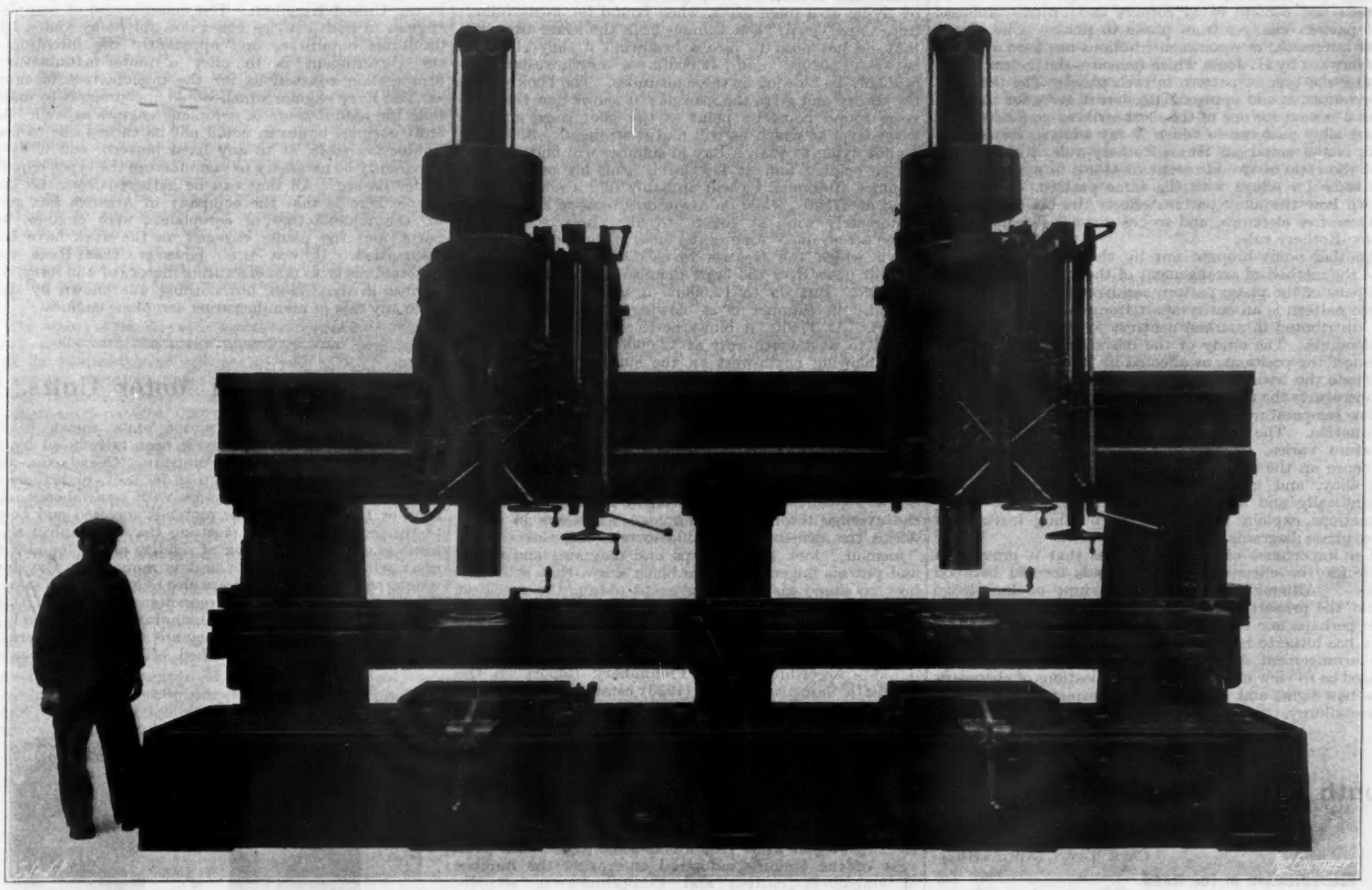
FIG. 4—*Arrangement of Voith Turbo Transmission for Railcars.*

* The Institution of Mechanical Engineers.—Abstract.

† Director of Turbine Department, J. M. Voith Maschinenfabrik, Heidenheim.

LOCOMOTIVE ROD BORING AND TREPANNING MACHINE

KITCHEN AND WADE, LTD., HALIFAX, ENGINEERS



influenced by the increase of the losses. In this case only systematic tests will produce the necessary information as to which design to select.

The attainable efficiency depends in the first place on the blading. The modern theory of flow and studies of the flow through turbine wheels, made in the design of turbines and pumps, have a decisive influence on the shape of the blades. The effect of this influence must be considered over the whole blade shape, and especially for the conditions at the inlet and outlet of the blade. The optimum efficiency in the impeller turbine and guide wheels (for non-adjustable blade angles) is theoretically attainable only at a single point of the efficiency curve. The efficiency curve can, however, be kept sufficiently flat and satisfactorily high for all the wheels over a reasonably large range of speed—given by the ratio n_2/n_1—by means of a suitable shape for the rotating and stationary blading. It is known that in turbines and pumps, for instance, more favourable efficiency curves can be obtained by making the runner blade angle adjustable (as in Kaplan turbines and pumps) and by corresponding adjustment of the angle of the guide vanes. This holds true also with turbo transmissions, but on account of their small dimensions a complicated design is involved if the blades are made adjustable, and this cannot be justified in consideration of the possible gain in efficiency and of the decreased reliability. In particular, the vibrations which occur with these movable blades under certain conditions reduce the reliability. Actual service tests on the reliability of adjustable vane constructions, however, have not yet been sufficient to give decisive results. Fig. 2 shows the Vickers-Coats type of torque converter with pivoted vanes in the guide wheel, arranged to adjust themselves automatically to the change in direction of flows.

In the application of torque converters to railcars the zones of low efficiency only predominate at the start and for a relatively short time, hence it is obvious that the advantage of reliability is essentially greater than the relatively small gain of efficiency obtainable by adjustable vanes over this range.

For street vehicles it can be regarded as an advantage if, when starting, the full motor speed is not immediately required. This condition can be arranged for by choosing for a constant impeller speed n_1 a primary torque curve M_1 which rises with a decrease in the secondary speed given by the ratio n_2/n_1. In this case the motor speed at the start is low and only attains its full number of revolutions per minute with increasing road speed.

Fig. 3 shows the diagrammatic arrangement of converter and coupling of a Voith turbo transmission. In this case the converter is shown with a two-stage secondary wheel, and the coupling is a normal Voith-Sinclair coupling. Either the converter or the coupling is brought into action at will by means of a filling pump, and is cut out by emptying through special discharge ports or valves. The change-over is effected without interruption of the power, since one circuit is filling while the other is emptying and the torque is maintained. Furthermore, since the power is transmitted through a circulating liquid, the change-over is made without any shock, regardless of whether it occurs exactly at the theoretical point or above or below.

A 200 h.p. Voith turbo transmission driven by a M.A.N. Diesel engine has been fitted to a two-axle railcar, having a maximum speed of 50 m.p.h., and intended for secondary lines with considerable gradients. Three of these cars are running without any trouble and have given excellent results during the trials. The control for this transmission is shown by Fig. 4. The oil tank and cooler are separately arranged beside the transmission, the cooler being in parallel with it. The filling pump is directly driven from the primary shaft and the control is effected by two valves operated by compressed air and electrically controlled from the driver's stand. The first of these valves controls the flow of oil from the oil tank to the control pump, and the second directs the oil either to the converter side or to the coupling side of the transmission. The oil flowing out of the transmission is pumped back into the oil tank by a second impeller mounted on the oil pump. Apart from these control valves, only the throttle or fuel control of the engine has to be operated. It is, however, also possible to provide for automatic control of the converter and coupling so that by means of a single lever the whole power transmission can be engaged, disengaged, or changed over at the required speeds.

Locomotive Rod Boring and Trepanning Machine.

THE tool illustrated at the head of this page is a locomotive rod boring and trepanning machine made by Kitchen and Wade, Ltd., and recently delivered to the L.M.S. Crewe Works. Hitherto, in tools of this type, motors and gear-boxes have been built on to the two outer columns, but in this design the motors are placed on the saddle. The changed arrangement not only eliminates all long driving shafts, but places every change of speed, feed, and spindle movement under the operator's immediate control. The engraving shows the powerful yet handy features of this 25½-ton machine, whilst its sturdy construction can also be observed.

The two heads are entirely independent of each other, and have each a 15 h.p. driving motor. The spindles, 8½in. diameter, are bored No. 7 Morse taper, and are balanced by dead weight. They have eighteen changes from 175 to 6 r.p.m., with nine rates of power feed from 118 to 10 cuts per inch, and a length of feed of 20in. Fine and quick hand adjustments are also provided. Spindles operate between 14ft. maximum and 3ft. 6in. minimum centres, and machined faces are provided for the use of dead set gauges to ensure repetition of centres. The upper portion of the head embodies the gear-box, containing hardened nickel-chrome gears mounted in ball bearings and running in oil, on six-splined shafts. Particular attention has been paid to ease of control, and all handles and levers have been brought to the lower parts of the heads. Heavy ball-bearing rollers support the heads on the broad top of the cross rail, and this design, together with the worm gear racking motion, provides a traverse of unusual ease. A secure double lock is provided to each head.

Adjustable steadies are mounted on the balanced steady rail, so that the spindles can be supported close up to the work. This arrangement, it is claimed, dispenses with the necessity of an initial pilot hole when trepanning, thus saving considerable time and leaving a usable core of material for other uses. The steadies are of the hinged type to facilitate the removal of heavy tools. The work bed is a strong, well-ribbed box casting, 18ft. 3in. in length and 3ft. wide, troughed all round for lubricant. Each spindle has its own motor-driven pump and fittings.

Atomic Arrangement in Metals and Alloys.

PROFESSOR W. L. BRAGG, F.R.S., delivered the twenty-fifth Annual May Lecture before the Institute of Metals on Wednesday last in the hall of the Institution of Mechanical Engineers, London.

The lecture dealt with the inner structure or atomic arrangement of metals and alloys. Professor Bragg said that X-ray analysis has given us a new method for examining solid bodies, because by observing the way in which these rays are scattered or "diffracted" by the regular pattern of a crystalline solid, the arrangement of the atoms in the solid can be deduced. The new discoveries about the structure of metals made by X-ray analysis formed the subject of the May Lecture given by his father, Sir William Bragg, to the Institute of Metals in 1916. Professor Bragg had been asked by the Council to take up the tale and give an account of some of the developments which have taken place since that date.

The great technical importance of metals and alloys makes any contribution to a knowledge of their fundamental structure a matter of considerable interest. Three main features of structure may be distinguished. There is first the atomic arrangement in single crystal grains of a homogeneous alloy which is in a state of equilibrium. There is, in the second place, the nature of the arrangement in an alloy which is not in equilibrium, but has been obtained in some other state by the quenching and annealing processes which are so widely used to give the alloy desirable properties. In the third place, there is what may be termed the "geography" of the alloy. By this is meant the shape and size of the crystal grains, their orientation relatively to each other, and the way in which blocks of the various different crystalline phases fit into each other if more than one is present. All these factors are of importance in determining the properties of the alloy, and all can be examined by X-ray methods.

"In so immense a subject," said the Professor, "I must confine myself to certain features, and I wish to limit my discussion to the first two factors described above. The third factor is of equal or even greater importance, but it is not so amenable to theoretical treatment, and I wish to show how the new knowledge of atomic arrangement can be made the basis of a theory, at any rate in outline, of alloy structure."

In general, when one metal is alloyed into another, a series of phases appear. Metal A dissolves a certain amount of metal B with a gradual alteration in properties as the proportion of B increases. At a certain composition, a limit is reached and for greater amounts of metal B a new phase appears as separate crystals of quite different properties mixed with the first phase. Their relative

amount increases till the whole structure consists of the new phase. Regions of single and double phase alternate as the composition varies from pure A to pure B. These phases are the nearest approach in an alloy system to the chemical compounds formed by combining elements. X-ray analysis has shown that each phase has its own definite pattern, such as a cubical array with atoms at corners and centres or at corners and centres of faces. The pattern changes from phase to phase. One of the most interesting of recent contributions has been a theory put forward by H. Jones which indicates the factors determining the type of pattern in each phase. The theory is only tentative and approximate, but it gives for the first time a reason for one of the most striking generalisations about alloy patterns to which X-ray analysis has led us. This is the empirical Hume-Rothery rule, which states that the ratio of free electrons to atoms in a structure is the same for alloys with the same pattern. Jones has shown how the alloy pattern affects the binding energy of these free electrons, and so has given a reason for the Hume-Rothery rule.

Another point brought out by the X-ray analysis is that the method of arrangement of the atom amongst the positions of the phase pattern can be varied widely. The phase pattern is an entity apart from the way the atoms are distributed in marked contrast to ordinary chemical compounds. The study of the movements of the atoms amongst the positions, as affected by heat treatment, can be made the basis of a very interesting theory. At high temperatures the atoms are shuffled up in a random way; at low temperatures they sort themselves out into a regular alternation. The course of the transformation as temperature varies, its rate of attaining equilibrium, its influence on the specific heat and electrical resistance of the alloy, and many other features can be predicted theoretically and agree with experiment. These transformations explain many hitherto puzzling features of alloy phase diagrams.

The importance of all this work is that it provides a basis for the chemistry of compounds formed between metals. Although an immense amount of knowledge about the properties of metals and alloys has been won, it is perhaps fair to say that a fundamental basis of this kind has hitherto been a real need. The determination of the arrangement of atoms in chemical compounds has caused us to view many of the generalisations of chemistry in a new light, and this has been conspicuously the case in metallurgy.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, April 17th.

Electrification of the Rand.

THE Railway Administration has now given instructions for a start to be made with the electrification of the railway system of the Witwatersrand. The lines to be electrified will be from Randfontein to Springs, from Apex to Welgewacht *viâ* Geduld, and Langlaagte to Orlando, the total distance involved being 223 track miles. Work will be begun almost immediately. The total cost of the electrification scheme itself is roughly £1,000,000, but in addition, tenders are to be called for immediately for seventy-two electric motor coaches at an approximate cost of £500,000. The parts will be imported and assembled in South Africa. There will be considerable expansion of Braamfontein and Germiston yards, and the scheme will involve the complete reconstruction of Kazerne—Johannesburg's goods-marshalling centre—where there has been congestion for many years. The elimination of locomotive sheds will create much more room and do away with the necessity of extending the present accommodation at Kazerne. A huge electrical repair depôt will be built at Braamfontein on a site at present occupied by thirty-five railway houses. The conference of senior railway officials which approved the immediate commencement of the electrification scheme, also considered tenders, and specification forms will be drawn up for the ordering of the great quantities of material required. The Administration may follow the method adopted in electrifying the extended portion of the Natal system, and use old rails as standards to support the overhead conductors. If, however, it is decided to make standards from new material, the Iscor (Iron and Steel Corporation) steel works will be required to supply the steel. While the motor coaches and trailers will be assembled in this country, the motors and bogie trucks will be imported. Recently the Administration had to order a large number of coaches complete from manufacturers in England, owing to the heavy demand for travelling accommodation, and if the shops are still unable to cope with the amount of work on hand, it may be necessary to order coaches complete from overseas. The electrification of the Rand railway system will release a large number of steam locomotives for service elsewhere, and will enable the Administration to scrap those of its engines that are very old. Mr. Douglas Leibbrandt, the chief electrical engineer of the South African Railways, will supervise, and the construction engineer will be Mr. W. E. Owens, district electrical engineer, at Durban.

Government Scientific Treatise.

Meteorological Memoir No. 1 was placed on the Table of the House of Assembly on April 1st. It is the first of the special treatises which are to be issued dealing with South African meteorology and climatology, and is the result of years of labour on the part of Mr. G. W. Cox. A great number of observers, even at remote places, co-operated in the collection of data. Daily, for years past, tiny "pilot balloons" filled with hydrogen have been sent up and observers have watched their course, and in this way it has been possible for the scientists to work out the direction and strength of the various winds at different times of the year. Airmen already know that the south-easter, which is so prevalent in the Cape Peninsula at a certain time of the year, gives place to a north-wester at 3750ft. This accounts for the fine individual performances that some airmen are able to achieve; the windwise pilot may fly from Cape Town to Walvis Bay in hours less than another with a similar machine but no air sense. For 4s., the price of this Government treatise, an airman will be able to plan his flights beforehand, and to work out that he can find a tailwind from Cape Town if he flies at 6000ft., and a tailwind to bring him back again at, perhaps, 10,000ft. Pilots have found that in summer they get the benefit of a tailwind by flying at a mere 750ft. when bound for Port Nolloth from Cape Town. But coming back the same afternoon they do not need to face a headwind if they climb to between 6000ft. and 12,000ft.—a north-wester will probably be blowing at these altitudes. The book proves the theory and gives the reasons; it shows how the wind veers round point by point as the pilot rises, and the exact level at which he will find it strongest. Similarly, a pilot flying to Walvis Bay in summer will find a south-easter helping him at low levels; on his return on a summer afternoon, he will probably find a nor'-nor'-east wind at 3750ft., while on a winter afternoon he will find a northerly wind at 4500ft. to blow him back to his home aerodrome. Among the facts of the air about Cape Town which the treatise reveals are that a westerly current flows over the Cape Peninsula up to a height of 35,000ft. But up to 12,000ft. it is influenced by the season. In summer it is blowing south-south-west at 1500ft. At 3750ft. it blows north-west. Then it backs round to west-south-west at 12,500ft. In winter, when it is blowing north-west on the surface, the clouds at 12,000ft. will be blowing west-south-west. The speed of wind on the ground in winter may be 2½ miles an hour on the average, but at 5000ft. it will be 15 miles an hour; at 10,500ft. only 10 miles an hour, and above that it increases all the time. In summer, when the surface wind is blowing at its average rate of 8 miles an hour at 750ft., it will be blowing at only 5 miles an hour at 1500ft.; but at 16,500ft. it will be blowing at 28 miles an hour on the average through the summer. Anywhere in South Africa the airman will be able to take this Government "memoir," look at the maps and diagrams and notes, and put his finger on a little black arrow that will show how to shape his course so as to obtain the speediest favourable wind.

Advance of South African Industries.

According to the Preliminary Report on the sixteenth industrial census (1933) established industries in South Africa increased from 3998 in 1915 to 7669 in 1933. The capital invested advanced from £27,552,000 to £68,753,000; the number of Europeans employed from 39,524 to 87,173, and non-Europeans from 101,178 to 192,450. European wages advanced from £6,740,000 annually to £18,823,000, and total wages paid from £8,913,000 to £21,875,000, while the total value of output rose from £46,435,000 to £90,427,000. It is revealed in the Report that while 1933 was in some respects the peak year of the Union's industrial enterprise, the number of employees—natives and Europeans—was actually higher in 1929–30 than in the following year, and wages paid showed a sharp decline. European wages fell from £20,507,000 in 1929–30 to £16,823,000 in 1933, and the total wages from £27,526,000 to £21,875,000. The peak year of industrial production was 1928–29, with a total value of output of £113,181,000, as compared with £90,427,000 in 1933. Much of this decline has now been recovered, and if there are no unforeseen hindrances this, or, perhaps, more likely next, year will show the peak year surpassed.

Mining Employment Increased.

As the gold mines continue to expand, their absorption of Europeans and natives in employment continues to grow. The latest mining statistics show that the steady improvement in this respect is being maintained. The January figures, which have now been released, give the number of Europeans employed on the gold mines on the Rand and elsewhere as 32,486, which means that 331 additional men were taken on in that month, and the extent of the improvement can be better appreciated when it is pointed out that the average number of Europeans in employment in gold mining during the year 1934 was 30,235. Native's employment improved similarly. In January there were 284,171 natives employed on the gold mines, an increase of 5481 on the figure for the previous month.

First Corrugated Sheets Rolled.

On Thursday, March 28th, the first corrugated sheets produced in the Union were rolled at the Pretoria Iron and Steel Works. It is hoped to keep one or two units in almost continuous operation on this work, as, of course, the whole essential of successful and economic production from the rolling mill depends on a steady and continuous output. There is, however, no fear of the mills being stopped for lack of orders for corrugated iron. The name "Iscor" is already on much of the steel plates and girders in building construction to-day, and will now be seen all over the country on outbuildings in towns and on farms.

Building Boom.

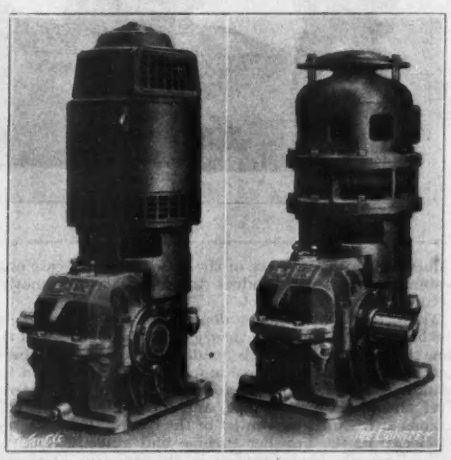
In the Union in January, 1084 buildings, costing £881,097, were completed; 1134 buildings, costing £1,154,649 were begun, and 2186 buildings, costing £1,234,000, were sanctioned. These rising figures clearly show that the boom has by no means reached its zenith. Johannesburg, of course, dominates building activity in the Union. In January it had £381,774 worth of new buildings on which work had begun; £240,235 worth of buildings had been completed, and £441,644 worth of building plans had been passed. Cape Town's corresponding figures for the same period were £201,395, £223,575, and £198,960.

Engine Factory for the Union.

Negotiations have been opened between the Union Government and the Ford Motor Company of South Africa in regard to starting an engine-manufacturing works. This is definite, but the lines on which the negotiations will proceed are at this stage a matter of speculation. When something similar has been broached before the intention has been to approach an overseas company with the object of establishing a factory for the manufacture of aeroplane, lorry, and light car engines in the Union. At present the Union is dependent on Great Britain and other countries for its aeroplane engines. The Government was anxious to receive an offer from a British firm, but little interest was apparently shown in the United Kingdom. The manufacture of aeroplane engines in South Africa could not, for many years, be a profitable enterprise, and apparently the intention of the Government is to offer a motor-manufacturing firm certain concessions for the manufacture of motor car and lorry engines which would encourage it to undertake the manufacture of aeroplane engines as well. Aircraft engines, however, could not be turned out to mass production scale, or to any fixed pattern, and it would apparently be necessary to manufacture the types required under licence. All that can be gathered from the Ford people here is that the company in America has given up the manufacture of aeroplanes, aero engines, and parts, and the plants engaged on the work have been dismantled. It was true, however, that there were negotiations as to manufacturing motor car and lorry, &c., engines in the Union, but nothing was known by them as to any talk of manufacturing aeroplane engines.

Worm Geared Motor Units.

THE new worm-geared motor units shown in the accompanying illustrations have been introduced by the British Thomson-Houston Company. Gear-boxes, with reduction ratios of 5 to 1 up to 50 to 1, or higher, are available for use in conjunction with squirrel-cage, slip-ring, or D.C. motors. The motor is spigoted and bolted to the gear casing, thus ensuring that mechanical alignment is unaffected by lack of rigidity of the foundations upon which the complete unit is mounted. The dead-weight and space occupied are also reduced to a minimum. All the worms used in the reduction units are of David Brown's latest "Radicon" high-duty pattern, and are composed of nickel steel. They are accurately generated, hardened, ground, and polished. The worm wheel rim



WORM GEARED MOTOR UNITS

is composed of centrifugally cast phosphor bronze, with a durable hard-wearing surface, while the worm shaft is composed of machined forged steel, the journals being finished by grinding. The low-speed shaft can be brought out on either side or on both sides of the casing. Cooling is effected by a fan just below the upper worm shaft bearing, and it serves to direct a stream of cool air from the top to the bottom of the casing ribs. Ball and/or roller bearings are provided and the motor has its own grease-packed bearing. The high-speed revolving element is, therefore carried on four bearings. A flexible coupling connects the motor to the high-speed worm shaft. The bottom half of the reduction gear casing forms an oil reservoir into which the worm wheel dips, and thorough circulation of the oil ensures adequate lubrication of all parts of the gears. The gear-boxes are made in six sizes, viz., 4in., 6in., 8in., 10in., 12in., and 14in. In all cases the overall efficiency is high, as exemplified by the following figures relating to an 8in. gear-box with a speed of 1450 r.p.m. at the input shaft :—

Ratio	5 : 1	10 : 1	15 : 1	25 : 1	50 : 1
Efficiency, approx.	96·25	95	93·5	90·5	83·5

The left-hand illustration shows a 20 h.p., 50 r.p.m., D.C. geared motor unit incorporating a 10in. gear with a ratio of 20 : 1, and the right-hand picture a 10 h.p., 39 r.p.m. squirrel-cage geared motor unit incorporating an 8in. gear with a ratio of 25 : 1.

MR. T. P. WILMSHURST, M. Inst. C.E., M.I.E.E., will complete his term of office as an Electricity Commissioner in July next, and the Minister of Transport has, with the concurrence of the Board of Trade, appointed Mr. C. G. Morley New, M.I.E.E., to fill the vacancy. Mr. Wilmshurst has been an Electricity Commissioner since November, 1926. He was formerly electrical and tramways engineer to the County Borough of Derby, and Chairman of the Engineering Consultative Committee of the East Midlands Advisory Board. Mr. Morley New is at present electrical engineer to the City of Cardiff. He is a Member of Council of the Institution of Electrical Engineers, a Past-President of the Incorporated Municipal Electrical Association, and Deputy Chairman of the National Consultative Committee of the Electricity Supply Industry. He has also been a Member of Council of the Electrical Research Association, and of the Electrical Development Association.

Greater London Drainage.*

A DEPUTATION from the London County Council to the Prime Minister (the Right Hon. David Lloyd George) on December 9th, 1920, made representations as to recent resolutions of the Council to the effect that the administration in Greater London of important and expanding local government services was becoming increasingly difficult by reason of the multiplicity of independent Local Authorities responsible for the services and recommending that an inquiry should be instituted by His Majesty's Government to determine what services and area should be brought under unified control, the authority to administer such services, and the relation of such authority to other local authorities in the area. The appointment on October 24th, 1921, of a Royal Commission on the Local Government of Greater London was the outcome of these representations.

* * * *

The report of the Royal Commission, issued in February, 1923, deals with the many phases of local government and its administrative services in and around London. It was not unanimous, there were two minority reports. In one respect, however, there appeared to be a measure of unanimity, namely, that as regards the administration of drainage services some modification of existing arrangements, and this over an area larger than the London County, was advisable.

The London County Council subsequently approached the Minister of Health by deputation with a view to seeing what action, if any, should be taken, having regard to the practically unanimous opinion of the Royal Commission that there existed a necessity for modifying the control of drainage and sewage disposal operations. It was ultimately decided that the Ministry of Health should arrange for an inquiry into the technical aspects of the matter. The London County Council consented to its Chief Engineer being associated with the Engineering Inspector to be appointed by the Ministry of Health to investigate the question of the drainage of London and the adjacent areas draining naturally into the Thames and its tributaries. The Chief Engineer of the Council at the time was Sir George Humphreys. He was in December, 1930, succeeded in office by Mr. T. Peirson Frank. At the request of the Ministry, Sir George Humphreys has, in conjunction with Mr. Frank, continued since his retirement to assist in the inquiry.

* * * *

The Thames catchment area extends from the Cotswolds to the sea, and embraces a much larger area than any over which London could be expected to extend, or over which unification of control would be necessary. The area selected and brought under review includes and encircles the London County, embraces the land within a radius of 25 miles of Charing Cross, is about one-third of the Thames catchment area, and extends from Maidenhead in the west to Corringham, about 6 miles below Gravesend, in the east; it includes Hemel Hempstead, Harpenden, St. Albans and Hertford in the north, Guildford, Reigate, Caterham, and Sevenoaks in the south. It is referred to in this Report as the Greater London drainage area, and embraces a total area of about 1928 square miles.

* * * *

The main artery for natural drainage purposes of London and its surrounding areas is the river Thames. From that part of the Greater London drainage area which lies outside the County of London there flow into the Thames sixteen independent tributary rivers and streams of sufficient importance to have names and to be familiar topographical features. They are, from west to east, the Colne, Crane, Brent, Lee, Roding, Beam, Ingrebourne, and Mar Dyke on the left bank of the Thames, and the Bourne, Wey, Mole, Hogsmill, Beverley Brook, Wandle, Ravensbourne, and Cray on the right bank. Several of these have their own tributaries almost as important as the main streams into which they flow. Amongst these are the Misbourne, Chess, Ver in the Colne valley, the Beane, Rib, Ash, Stort, in the Lee valley, Cripsey Brook in the Roding valley, Hale Bourne, Stanford Brook in the Wey valley, the Pool and Quaggy rivers tributaries of the Ravensbourne, and, one of the largest, the Darent, a tributary of the Cray. These rivers and streams form the natural drains of the particular valleys and districts through which they pass. Of the sixteen which flow directly into the Thames, two only, and those two on the south side—the Wandle and the Ravensbourne—flow partly through the County of London, and discharge into the Thames within the county. Two others, the Lee and the Beverley Brook, form part of the boundary of the county on the east and west sides respectively; while a branch of the Lee cuts through a corner of the county. Into eleven of these sixteen rivers no part of the County of London drains, and only comparatively small parts thereof drain into the remaining five. A number of minor rivers and streams drain the area which is the present County of London. Prior to the early part of the eighteenth century they flowed in open channels discharging into the Thames within the limits of the county. The principal ones on the north side of the Thames from west to east are Stamford Brook, Counter's Creek, Ranelagh (Westbourne), King's Scholars Pond (Tyburn), the Fleet, Walbrook, Shoreditch, Hackney Brook, and Black Ditch; those on the south side, in addition to the two already mentioned, also from west to east, are the Graveney (a tributary of the Wandle), Falcon Brook, Effra, Duffield, and Earl Sewer. Nearly all those on the north of the Thames are now covered in and utilised as sewers; but on the south side, whilst some are wholly or partly covered in, many are still open.

* * * *

The total capital expenditure on main drainage and sewage disposal works by the Metropolitan Board of Works and the London County Council from 1856 up to the end of March, 1930, has been nearly £16,000,000. During the last forty-four years the rate has not exceeded 4·92ld. in the £, the maximum pre-war rate was 3·442d. in the £, the present rate, 1933–34, being (subject to revision) 2·977d. in the £. The total population served in the year 1931 was 5,558,269; on the north of the Thames 3,596,313 and on the south 1,961,956. Of these latter figures, about 1,113,720 and 47,546 respectively relate to population outside the County of London. The history of the main drainage system of London County shows that at intervals over a succession of years considerable sums have been laid out as capital expenditure upon additions to the system. It cannot be said that finality has been reached in this respect. The Thames and its tributaries, however, receive effluents from a large number of sewage disposal works situated in that part of the Greater London drainage area which lies outside the area served by the London County Council. These works and the areas in which they lie will be discussed in a later chapter.

* * * *

The outside area is more than eleven times the area dealt with by the London County Council. It lies approximately within 25 miles of Charing Cross and is confined to that part of the watershed of the river Thames which comes within that radius, departure outside these limits only occurring for exceptional drainage reasons or to ensure that the boundary follows existing civil parish boundaries.

* * * *

The total number of sewage disposal works in the area, excluding a few small works and those belonging to institutions and private persons, is 182. In the 1769 square miles concerned, there is, on the average, one sewage disposal works in every 9½ square miles. Table I shows the area of each of the eight sections and the density of distribution of works in each section:—

TABLE I.

Section No.	Catchment area.	Area, square miles.	No. of sewage disposal works. Total.	Per 10 square miles.
1	East of the river Roding	137·8	16	1·16
2	River Roding	124·6	17	1·36
3	River Lee	292·5	37	1·26
4	Rivers Brent and Crane	116·9	23	1·97
5	River Colne	353·7	39	1·11
6	River Wey	188·4	14	0·74
7	Rivers Mole and Hogsmill	199·0	21	1·06
8	Beverley Brook and rivers Wandle, Ravensbourne, &c.	356·1	15	0·42
	Totals	1769·0	182	1·03

The greatest density is in the Brent and Crane section where there is a disposal works in practically every 5 square miles. The lowest density is in Section 8. This is due to two reasons—first, the Croydon Corporation deals at the Beddington works with the sewage of several districts lying to the south of the borough; secondly, there are several sewerage boards in the section, the largest of these are the West Kent and Darenth Valley Main Sewerage Boards, whose whole combined area of 167 square miles is dealt with at the West Kent Main Sewerage Board's works in Dartford urban district.

The total area covered by sewage disposal works sites amounts to between 8 and 9 square miles. The largest of these is Croydon's Beddington site of 684 acres, whilst the second largest is the Watford sewage farm, extending over 265 acres. Examples of almost every method of sewage disposal, from simple treatment by broad irrigation to complex treatment by means of activated sludge, are to be found in the area. By far the commonest method is that of continuous flow settlement followed by percolating filters and humus tanks, the effluent being discharged into a watercourse. The ultimate destination of the effluent from the disposal works is of interest. The totals are summarised in Table II below:—

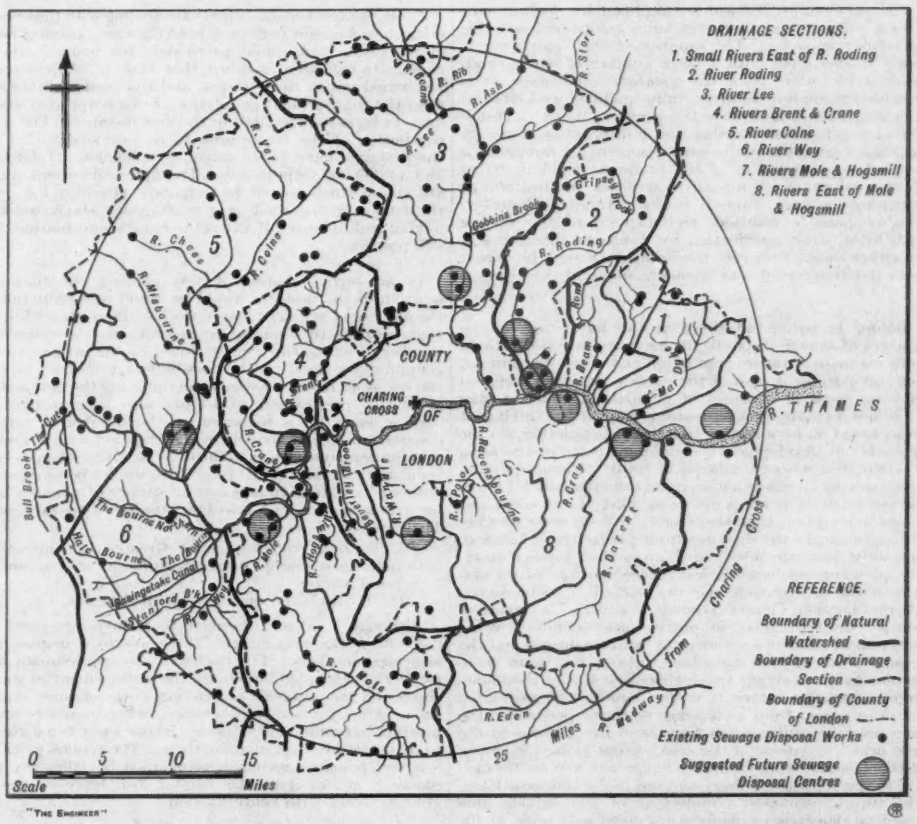
TABLE II.

	Dry-weather flow, gallons per day.
Effluent discharged into rivers and streams (non-tidal)—	
(*a*) After full treatment	64,755,000
(*b*) After broad irrigation treatment	1,744,000
Effluent discharged into tidal waters—	
(*a*) After full treatment	19,259,000
(*b*) After tank treatment only	17,141,000
Effluent absorbed—	
(i) After full treatment:	
(*a*) By gravel overlying London clay	527,000
(*b*) By gravel overlying chalk	448,000
(*c*) By chalk	422,000
(ii) After broad irrigation treatment:	
(*a*) By sand or gravel overlying London clay	3,619,000
(*b*) By lower Greensand	57,000
(*c*) By chalk	2,951,000
Total	110,923,000

These figures are exclusive of those relating to the London County effluent, which amounted in 1932–33 to 296,000,000 gallons per day, the dry-weather flow being estimated at 267,000,000 gallons per day. The question of population generally is dealt with later, but it may be mentioned here that the population of the outside area according to the census of 1931 was approximately 3,512,000, and of this number about 2,922,070 were actually served by sewage disposal works belonging to local authorities or sewage boards. The balance was served by more primitive methods. The total dry-weather flow of sewage, 110,923,000 gallons per day, from this population of 2,922,070, was equivalent to an average of 37·9 gallons per head per day. The sewage disposal works should be, and in the majority of cases are, capable of fully treating up to three times the dry-weather flow, and partially treating between three and six times such flow, in accordance with the standard set by the Royal Commission on Sewage Disposal; but the extent of such treatment varies according to the point of discharge of the effluent outfall sewer; when the discharge is directly into the lower tidal reaches of the Thames, such full treatment is not at present insisted upon as when it is into the upper tidal reaches, into the Thames above Teddington and into all non-tidal watercourses.

* * * *

What has happened and is happening round London is that while many sewage disposal works were, and others are, being established in more or less open country, the communities which such works serve and adjoining communities in the neighbourhood have expanded until eventually the works have become or will it is evident become embedded in urban areas. In many cases the sites



"THE ENGINEER"

GREATER LONDON DRAINAGE AREA SHOWING PRESENT AND SUGGESTED SITES OF SEWAGE WORKS

* Excerpts from a report by J. R. Taylor, M. Inst. C.E., Engineering Inspector of the Ministry of Health; Sir George W. Humphreys, M. Inst. C.E., late Chief Engineer of the London County Council; T. Peirson Frank, M. Inst. C.E., Chief Engineer of the London County Council. His Majesty's Stationery Office. Price 17s. 6d. net.

originally acquired for such works, although sufficient in area at the time and for what seemed to be a reasonable future period, have proved too small. Before this is fully realised, the town grows round and closely up to them. The results are that the works cannot be extended as they should be—or only with the greatest difficulty—and frequent complaints arise from people living in the neighbourhood, the principal causes of complaint being smells and flies. If works are not extended from time to time to meet the requirements of increasing population, complaints of nuisance are accompanied by that really far more serious trouble, the pollution of watercourses, a constant source of potential danger to the public health.

* * * *

It has been mentioned that drainage difficulties of some districts close to the County of London have been met by the London County Council acceding to requests from the authorities of such districts that their sewage should be taken into the London County Council system of sewers. But these requests have only been granted after long and difficult negotiation involving the passing of Acts of Parliament; and, even so, it cannot be said that the difficulties of the local authorities concerned have always been fully disposed of. In certain of the more recent cases conditions have perforce had to be laid down which result in a very considerable liability with respect to the disposal of storm water—and even of sewage in times of emergency—still remaining with the outside authority.

* * * *

The case for or against unification of the drainage of Greater London can be decided only after a careful examination of the present state of affairs, both as regards movements of population and drainage facilities, coupled with a proper appreciation, if not decision, as to the steps which should be taken to control development over the Greater London area in future years.

A very important part of the problem of the drainage of the Greater London area is therefore to discover whether any scheme can be evolved which, without placing undue financial burdens upon the present generation and upon posterity, will result in satisfactory drainage unification.

The problem of disposal is simplified by dealing with sewage effluent and sludge in large quantities, and this leads to economies. The number of staff employed is much smaller than with a large number of works, and, incidentally, what is of the greatest importance, it is possible to employ the most fully qualified and efficient men available to look after the works at no extra cost—probably at less cost—further, the multiplication of sewage disposal works, always potential sources of nuisance, is avoided. One solution of the problem would therefore be the adoption of intensive artificial purification at centralised sewage disposal works. There is, however, another possible solution—the disposal of the sewage with little or no purification by discharge into the sea. In either case, however, the solution would be, apart from the question of management, inevitably costly.

* * * *

Before preparing anything in the nature of outline schemes of sewage disposal, the necessity arises of making some estimate of future population and of its distribution. For this purpose a plan of the outside area was prepared showing zones of densities of population. Such a plan could not do more than represent a more or less intelligent guess based on (*a*) existing densities of population, (*b*) the character of developments in different parts of the area, (*c*) estimates (where available) of future ultimate population made by the local authority of each district, (*d*) information as to what areas are never likely to develop, and (*e*) an assumption that the density will decrease roughly in proportion to the distance from the centre of London, but at a less rate near the Thames than further away. The plan showed hypothetical future densities of population in the area outside the area served or to be served by the London County Council sewers. The zones of density were irregular in outline near London, owing to the more definite knowledge of local conditions and the requirements of the immediate future, but were more regular in the outlying areas where necessarily the knowledge as to the future is more vague. The estimated densities varied from an average of thirty persons to the acre near the centre to an average of five persons to the acre near the outside of the area, except along the course of the Thames, where a higher figure was taken—twenty-five to the acre near Tilbury and ten to the acre near Eton. The future estimated populations of the outside area based on densities so planned are given in a table in the Report. The grand total of, say, 13,000,000, given would include the present population of the outside area. If to this total be added a population of 5,760,000, a round figure taken to represent the future population of the area served by the London County Council, the total within the Greater London area would be approximately 18¾ millions. Starting from the 1921 census of 2,649,967, a population of 13 millions in the outside area would be reached in about:—

50 years if the rate of increase is taken at 30 per cent. per decade.

80 years if the rate of increase is taken at 20 per cent. per decade.

160 years if the rate of increase is taken at 10 per cent. per decade.

The area under review by the Greater London Regional Town Planning Committee was roughly the area within a radius of 25 miles from Charing Cross, and covered 1846 square miles, compared with 1928 square miles dealt with herein. After dealing at some length with the question of the amount of land to be set aside for open spaces, the Committee's First Report (on page 15) says:—

"Allowing for the areas already developed and for the whole of the existing and proposed open spaces set out above, there would be well over 1000 square miles within the Greater London region available for further building. This area would allow the present rate of growth to continue undiminished for over 200 years. At only five houses to the acre and four persons per house, this would represent an additional population of 12,800,000."

The total population in the 1846 square miles would then be 21,454,000, made up as follows:—

Estimated population, 1927	8,653,559
Additional population	12,800,000
	21,453,559
Say	21,454,000

The average density over the whole of the area would be 18·2 persons per acre.

Consideration of future population from the above points of view would, at first sight, suggest that a figure of 20 millions for the whole area is a feasible possibility, and that to have a figure of this order in mind when approaching the sewage disposal problem would not be unreasonable.

On the other hand, from information supplied by the Registrar-General, it was evident that to adopt as a basis of calculation a population in the neighbourhood of 20 millions would be to go considerably beyond a reasonable range of probability.

* * * *

After due consideration of the figures, ultimate populations of 11,330,000 and 15,000,000 have been taken for purposes of calculation, the former being regarded as within the range of probability, the latter as not outside the region of possibility, if not in 1971, then at some time in the not too distant future.

* * * *

In the schemes considered later it has been assumed that 110 gallons† per head per day should be regarded as the equivalent of "three times the dry-weather flow," the amount, in fact, that must be disposed of as "sewage" proper; any excess over this to be regarded as "storm water" to be disposed of generally as at present. Where partial treatment of storm water is necessary, the amount to be so treated would be all flows at rates from 110 to 220 gallons per head per day.

In view of the greater proportion of combined and partially separate systems in the Greater London area as a whole, it has been assumed that flows up to six times the dry-weather flow may be anticipated from all districts.

* * * *

In any comprehensive scheme for dealing with the sewage of Greater London it is very unlikely that outlying parts of the outer area would participate for many years to come. It has been assumed that such a scheme would be carried out in three stages, and that considerably less than the total present population of the outer area would have to be accommodated in the first instance. The total population of the whole area to be provided for in the three stages have been taken at 8,560,000, 11,330,000, and 15,000,000 respectively. The first and second stages are those which should be definitely provided for; the third may be regarded as a contingency stage, unlikely having regard to the Registrar-General's information, but still possible.

* * * *

In an earlier chapter it was pointed out that one solution of the problem would be found in a reduction in the number of sewage disposal works. From this it follows that, subject to financial considerations, the fewer the number of works the greater would be the benefit, to the community generally. The possibility for discharging into the sea as an alternative solution implying the elimination of sewage purification works has also been mentioned. Two schemes for a reduction in the number of sewage disposal works and one scheme for the discharge of sewage into the sea have been examined. None of the schemes have been worked out in detail. This would be impossible without an extensive and careful survey of possible lines for trunk sewers and possible sites for disposal works. They are as follows:—

I. To treat the sewage of Greater London at (*a*) twenty-three sewage disposal works, at (*b*) ten sewage disposal works.

II. To discharge such sewage into the sea.

Although I (*a*) and (*b*) refer to twenty-three and ten disposal works respectively, these are to a degree only arbitrary numbers. The choice of the approximate sites for works depended largely on the arrangement of watersheds and the situation of existing works of some magnitude. After further consideration, other numbers might possibly be found more suitable, the tendency being always to reduce rather than increase them. The general principle followed is centralisation accompanied by efficiency and economy in management; capital cost, however, inevitably increases with centralisation.

* * * *

The scheme for twenty-three sewage works is not put forward as a satisfactory solution of the problem or one to be recommended. It would be little more than a stepping-stone between the present policy of each district working out its own salvation irrespective of its neighbours, and the more thorough policies of adopting some such schemes as are outlined under I (*b*) and II below. Moreover, the saving in cost compared with I (*b*) is small, taking into consideration the greater benefits likely to result from the adoption of the latter scheme.

* * * *

The plan indicates diagrammatically by large circles the localities where such works are or would probably be situated.

The total ultimate estimate of cost of carrying out this scheme is £50,000,000, made up as follows:—

Estimate.

	£
First instalment	28,000,000
Second instalment	13,500,000
Third instalment	8,500,000
Total	£50,000,000

* * * *

The discharge of crude sewage into the open sea is possible and is effected without prejudicial results in many places both at home and abroad. Given suitable physical conditions, it is at once the most convenient and economical method of disposal. The maintenance and running costs of purification processes and the sludge difficulty are non-existent. The purification tank is the sea, but the outfall must be situated so as to avoid contamination of adjacent foreshores.

† This is three times a dry weather flow of about 36·7 gallons per head per day.

* * * *

The distances in a straight line from Charing Cross as a centre to the coast line are approximately:—

	Miles.
(1) To Havengore Head (7 miles north-east of Shoeburyness)	43
(2) To Goring (between Worthing and Littlehampton)	52
(3) To Dungeness	63

* * * *

In all the circumstances there is little doubt that if London sewage were discharged untreated—or even partially treated—into the sea, Dungeness, as a point of discharge, has advantages far overshadowing those of other places. For this reason the broad possibilities of laying a main outfall trunk sewer from London to Dungeness with tributary sewers from centres in the Greater London area discharging into it have received special attention herein. It may be said at the outset, however, that many technical difficulties would no doubt be encountered in the construction of the outfall sewer and the harmless disposal of the sewage in the waters of the Channel. It is questionable whether the financial commitments incidental to the construction of an outfall sewer from London to the sea would place the scheme within the range of practical possibilities. It is estimated that the capital cost of a first instalment of such a scheme would be in the neighbourhood of £47,000,000.

Prices remaining unaltered, it is estimated that the cost of second and third instalments would be approximately £19,000,000 and £21,000,000 respectively.

To these sums would have to be added the cost of tributary sewers and subsidiary pumping stations in the different sections. For this purpose it is not unlikely that an expenditure of some £15,000,000 would be entailed, as a first instalment, following by second and third instalments of £6,000,000 and £2,000,000 respectively.

Summary of Estimate.

	£
First instalment—	
Trunk sewers	47,000,000
Tributary sewers	15,000,000
Total	£62,000,000
Second instalment—	
Trunk sewers	19,000,000
Tributary sewers	6,000,000
Total	£25,000,000
Third instalment—	
Trunk sewers	21,000,000
Tributary sewers	2,000,000
Total	£23,000,000
Grand total for three instalments	£110,000,000

The adoption of schemes I (*a*) or I (*b*) would not preclude the adoption of II, the scheme for disposal at sea, at some future time. This aspect of the problem has been kept in view in siting the disposal works under I (*a*) and I (*b*).

* * * *

Conclusions.

The advantages resulting from the adoption of schemes I (*b*) or II may be summarised as follows:—

(1) Nuisance centres, or potential nuisance centres, greatly reduced in number; in round figures from, say, 200 to 10.

(2) Difficulties of a number of different authorities in obtaining new disposal works sites and in extending their existing works eliminated.

(3) Difficulty of preventing building close up to disposal works and consequent frequency of complaints avoided.

(4) Improvement of amenity conditions in many areas now centred round sewage disposal works that will be abandoned, and, in many cases no doubt, converted, if not used for building purposes, into recreation grounds or permanent open spaces.

(5) Enhanced rateable value in all such areas.

(6) Possible sources of river pollution from sewage and sewage works effluents greatly reduced in number.

(7) Greater and more efficient protection of sources of water supply.

(8) The disappearance of the sewage disposal problems of some 140 local authorities, as in the case of the area served by the London main drainage works and the West Kent Main Sewerage Board.

(9) By bringing the service of sewage disposal under more centralised control the possibility of adopting the most satisfactory systems of main sewers for the whole of the natural drainage areas concerned, irrespective of artificial administrative boundaries, and without having to resort to lengthy and frequently ineffective negotiations.

The growing necessity for combination is brought out by the recent action of the Middlesex County Council in obtaining powers by an Act of Parliament for carrying out the comprehensive scheme of sewerage and sewage disposal which has been referred to above. The outstanding conclusion is that, from an engineering point of view, co-ordination and unification over a wide area are essential in order to secure the most effective and satisfactory method of dealing with the sewage of Greater London. The larger the area that can be amalgamated within a reasonable limit, the more effective and beneficial should be the result, and, of the schemes examined, it is thought that scheme I (*b*) would present the most satisfactory solution of the problem.

Recommendations.

(1) That all arrangements for sewage disposal in and around the Metropolis should be co-ordinated and planned with regard to an area of 25 miles radius (or thereabouts) from Charing Cross.

(2) That for this purpose consideration should be given to a scheme whereby the whole of this area would be served by ten, or fewer, centralised disposal works.

(3) That within this area all further main sewerage and sewage disposal works, or extensions of existing works, should be designed so as to conform with the foregoing.

(4) That special measures should be taken to give effect to the above recommendations.

J. R. Taylor.
G. W. Humphreys.
T. Peirson Frank.

July 23rd, 1934.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Reduction of the Import Duties.

The Government has not lost much time in reducing the duties upon iron and steel to the 33⅓ per cent. level ruling before the advance on March 26th, and have thus made effective the arrangement entered into between the British and Continental steel makers. In recommending this reduction the Import Duties Advisory Committee state that the reduction is for a period of three months, and that "in the absence of any further recommendation from us the higher rates of duty at present in force should again become operative at the end of that period." This alteration took effect on May 8th. It would seem that although the Government has acceded to the request which the Continental steel makers submitted to the British steel industry, it has left a powerful weapon in the hands of the British Committees negotiating for a long-term agreement with the Continent and the extension of the arrangement to the export markets. Failure to agree upon these points within the next three months automatically restores the import duties to the rate of 50 to 60 per cent., which has just been abandoned. It is understood that the Cartel is meeting in Paris this week to discuss the situation and to subdivide the quota for the British market. So far no price alterations in Continental products have been notified, but naturally business in this class of steel practically ceased until the lower range of duties again became operative. Reports from the Continent indicate that the volume of export business is declining, and this is borne out by the decision of the Cartel to fix the exports for the current quarter at 150,000 tons of bars and 260,000 tons of semis, compared with 160,000 tons of bars and 300,000 tons of semis for the preceding quarter. Complaints have been made as to the difficulties arising from the Cartel's new policy of centralising sales of various products. Apparently, however, it has administered a check to the practice indulged in by some of the Continental steel works of selling at prices lower than the official Cartel quotations. This is particularly noticeable in the Indian market, and where a short time ago steel bars for that destination could be bought at as low as £3 18s. f.o.b., these cheap prices have disappeared and the figure is now about £4 3s. 6d.

Pig Iron.

The market has not been particularly busy of late and the interruption of the Jubilee celebrations had little effect upon the situation. For some weeks buying has been chiefly confined to small parcels so far as foundry iron is concerned, but during the last few days a rather brighter tone has developed, due in part to the negotiations for the renewal of some expired contracts. On the North-East Coast business in Cleveland iron has been quiet, but producers declare that a more confident note is developing in the market. Steady deliveries continue to be made to the local foundries and the requirements of the Scottish light castings industries appear to be slowly gathering strength. The slackness of the latter department has been one of the disappointing features of the pig iron market, and a sustained improvement would have a beneficial effect upon the whole situation. Export trade in Cleveland iron remains indifferent, but the home demand seems sufficient to account for the make, and it is stated by the producers that most of their stocks have already been sold. In the Midlands a brisk demand for foundry iron developed after the Jubilee celebrations, but business has been slow to mature. Consumers are under the impression that the Midland makers are carrying heavy stocks of iron and are inclined to use this as a weapon with which to bargain. So far, however, success has not attended these efforts, but the effect has been to hold up a certain amount of business, which, it is anticipated, will shortly have to be placed. The Scottish producers of pig iron seem to be comfortably placed as regards contracts, but they complain that little business of an important character has been transacted recently. Probably this is because most consumers have considerable contracts running against which they can specify. Some of these are approaching completion. In the Lancashire market the demand is fairly good, but the quiet conditions ruling in the textile industry operate against a brisk business in pig iron. The situation in the hematite market is unchanged. The home demand has improved and some substantial contracts have been placed for third quarter delivery. Shipments to Italy have been resumed, but apparently these are against old contracts.

The North-East Coast and Yorkshire.

Conditions of great activity rule at the North-East Coast steel works and operations were resumed immediately after the Jubilee holiday. The agreement with the Continental steel makers has been followed by a large increase in inquiry on home account. The production of structural steel has been maintained at a high level, and although rather quieter conditions have been noticeable of late so far as new business is concerned, the tonnage of orders on the makers' books ensures a busy period for some time to come. The constructional engineering shops are well employed and new business has come forward more freely from this than any other industry. There has been an inclination lately, however, for the engineering industry to buy sparingly until the international situation becomes clearer, and as a result individual orders have been small. The railway mills have been busy. Some export orders have been worked off, and it is interesting to note that a shipment of rails was made recently to Canada. On the other hand, the requirements of the shipyards on the North-East Coast leave much to be desired. There has been no real revival in the industry on this coast, and the scarcity of specifications for shipbuilding steel is one of the weak spots of the position. Slightly more business is reported to have been transacted in semis, but, generally speaking, consumers have shown reluctance to add to their existing commitments. Many of them have running contracts against which they can specify, whilst others are carrying heavy stocks. The producers, however, believe that the lull in new business is only temporary and that with the limitation of foreign imports there is certain to be a heavy demand for semi-finished steel in the near future. Busy conditions continue to rule in the Yorkshire steel market and the Sheffield production of basic steel is maintained at a high rate. Business in acid steel, however, has been declining for some little time, and at the moment there seem no prospects of a revival in the demand. A brisk business has passed in steel strip in spite of considerable importations from the Continent against old contracts. The demand for small bars, also, has improved, although this market suffers from the stocks in the hands of distributors and consumers. No lessening in the demand for stainless steel is apparent; but, on the other hand, there is a tendency for business in special steels to decline.

Scotland and the North.

Whilst new business has shown a tendency to decline, the activity at the steel works has been scarcely affected. The shipyards on the Clyde and at Belfast continue to take heavy tonnages of steel against contracts booked some time ago, but it is realised that this rate cannot long be maintained unless there is an increase in the number of orders for new ships. Some of the contracts for shipbuilding steel are approaching completion, and new work to take their place is not in sight. The constructional engineers are fairly well off for work, and recently some fresh contracts were taken which should help to maintain the output of sections in Scotland. The marine engineers, also, are busily employed, and their steel requirements are on a substantial scale. The builders of railway rolling stock have a considerable amount of work in hand, and are specifying freely against contracts they placed some time ago with the steel works. The lull in the demand for steel sheets has passed to some extent, and recently there have been some further bookings on export account. In some quarters the prospects of an improved business with Canada are regarded as being distinctly good. The home demand for sheets has revived somewhat, but the seasonal demand from the motor car industry is now practically over and this naturally reduces the volume of new business reaching the mills. The re-rolling mills benefited from the recent increase in the import duties and are not well pleased at the reduction, notwithstanding the limitation of Continental imports. Work in this department is irregular, but the demand for small bars and strip shows a tendency to improve. In Lancashire more activity has prevailed, and the position compared with that ruling a year ago shows some improvement. The constructional engineers are busy for the most part, although some firms are not so well provided with work as in the early part of the year. There is a tendency for this branch of the trade to order in small parcels as the material is required. This, of course, applies to the smaller firms and not to those concerns engaged on important contracts. The local makers of bright steel bars are well occupied and there is a steady demand for special steels. The plate mills have a fair tonnage of orders in hand, but new business has been scarce during recent weeks.

Current Business.

Orders for two motor vessels for Sir Arthur Sutherland have been secured by Wm. Doxford and Sons, Ltd., of Sunderland. The vessels will be 9000 tons d.w. and fitted with oil engines. Thos. W. Ward, Ltd., Sheffield, have acquired Palmers Jarrow Shipyard from National Shipbuilders' Security, Ltd., for dismantling. The German warship "Bayern," which was recently raised at Scapa Flow, has arrived at Rosyth dockyard to be broken up by Metal Industries, Ltd. The Furness Shipbuilding Company, Ltd., of Haverton Hill-on-Tees, Durham, has secured a contract from Sir William Reardon, Smith and Co., Ltd., Cardiff, for two cargo ships. A contract for replacing forty-seven German safety valves fitted to the boilers of the Cunard-White Star liner "Majestic" has been placed with Cockburns, Ltd. The new valves will be 3in. double cast steel Cockburn-MacNicoll improved high-lift safety valves. The Air Ministry has placed an important order for four-wheel chassis with Albion Motors, Ltd., of Glasgow. The Department of Overseas Trade reports that the following contracts are open for tender:—Johannesburg City Council: Road-making plant, comprising petrol-driven track-type tractor, leaning wheel grader, scarifier, and steam-driven, twin high-pressure, three-wheel-type road roller (Johannesburg, May 25th). South African Railways and Harbours: Four narrow-gauge (2ft.) locomotives, class "N G/G. 13" 2–6–2 + 2–6–2 type (Johannesburg, June 24th). Melbourne City Council: Supply, delivery, and erection of boiler plant, comprising water-tube boiler, superheater, pulveriser, &c. (Melbourne, June 17th). Argentine State Railways Administration: Seamless steel tubes for locomotive boilers, superheater coils, and stationary boilers and flexible steel tubing for steam, &c. (Buenos Aires, June 4th). Cairo, Ministry of Public Works: Electrically driven insulating oil purifier of the self-contained portable type for use at Edful power station (Cairo, June 3rd); supply, erection and delivery of two sewage pumping units at the Giza pumping station, comprising centrifugal and vacuum pumps, fuel oil engines, section and delivery pipes and recorders, electric generating sets, with switchboard, 30-ton capacity fuel oil storage reservoirs, air compressor sets, elevated water tower, with capacity of 20 cubic metres, electrically driven workshop, &c. (Egypt, June 5th).

Ferro-Alloys.

The position in the ferro-alloy market has varied little for some time past. On the whole, the demand has been steady, but there has been no sign of an expansion in business such as was prophesied early in the year. In this, however, the ferro-alloy section has merely reflected the conditions which have ruled in other departments of the iron and steel markets. Of late the tone of the market for ferro-chrome has had a rather better appearance, and the demand has steadily increased. Whether or not this movement will continue is difficult to judge; but some holders of stocks have taken the opportunity to get rid of their material at prices slightly under the ruling market figure. This should strengthen the position, if anything, by eliminating tired holders; but the demand must gain more vigour before the market can be regarded as satisfactory. Steady conditions have ruled in the ferro-silicon department. Business has shown signs of improving, but the quantities changing hands have been on the small side, and consumers seem to have adopted a policy of buying only for their immediate needs. In some cases, however, these should become substantial during the next week or two, as a few contracts will shortly run out. Users of ferro-tungsten have been expecting a reduction in the price for some months, but no important movement has taken place. The comparative steadiness of the market, however, has not shaken their belief, and as a result there is a complete absence of forward buying. In ferro-molybdenum also no important transactions have been reported and few buyers appear to be interested in forward contracts. The chief feature of the market for silico-manganese is its steadiness. Deliveries are on a regular scale and prices have been unaltered for a long period. Business in ferro-cobalt, on the other hand, has been checked by the rather high price level. There has been a more active demand for ferro-titanium and prices show a stronger tendency. Business, however, has consisted almost entirely of small lots. British suppliers of ferro-manganese have been disappointed lately by the failure of the market to develop activity.

Copper and Tin.

The situation in the electrolytic copper market seems to be steadily improving, and there is no doubt that consumption of the metal in this country has increased since it became evident that the producers' scheme for restricting supplies would be effectively operated. This week there was some interruption in the industrial demand due to the holidays, and inquiry became active directly work was resumed. Of course, it will take some time before the market responds to the producers' scheme, and at the moment supplies are quite equal to the requirements of consumers. Quotations are steady, the price for electrolytic being firm at 7.87½c., or £36 7s. 6d. to £36 10s. c.i.f. It is notable that the exports of American copper were considerable during March, and totalled 20,953 tons. For the first three months of this year the exports amounted to 60,070 tons. In March, Japan took the largest quantity with 5572 tons, Great Britain being next with 4022 tons, and France third with 3096 tons. Business in the standard market has been moderately active. One of the features of the position is that the stocks at the end of March had reached 77,000 tons, but so far from having a "bear" influence the market seems to regard it as a satisfactory feature. Probably, it is realised that whilst the copper market is in a state of transition as a result of the producers' restriction scheme the presence of a large stock in this country is desirable. . . . There has been no alteration in the situation in the tin market. Holiday conditions have ruled and a slightly easier tone has developed in prices. The backwardation has increased and has been as much as £5 10s. Now and again during the past week interests usually associated with the Control have supported the market, and as is generally the case other dealers have followed suit. This week it was anticipated that the backwardation might become accentuated as heavy contracts matured; but as it turned out the market has not been adversely affected. High premiums continue to be charged for brands, £12 being asked for Banca spot, £8 for Banca c.i.f., and £8 for Straits tin.

Lead and Spelter.

The position in the lead market changes but little. The industrial demand in this country shows practically no diminution. In some quarters it is suggested that the failure of an announcement regarding the modification of the import duties has an adverse effect on the market, but it is difficult to see any signs of this. Consumers, at any rate, appear to be pursuing their normal practice so far as purchasing supplies is concerned without hesitation. The situation on the Continent is not so clear, but at times lately a strong demand has sprung up, particularly from Germany, and, of course, the market attributes this to increased requirements for munition purposes. According to American figures the production of lead in March totalled 128,200 tons, compared with 124,000 tons in February, the stocks of lead at the end of March being given as 228,230 tons. . . . A better tone has ruled in the spelter market than for some weeks past. This is partly due to the improvement in other non-ferrous metal markets. As in lead, it is anticipated that the duty upon spelter will be readjusted and that as a result business in this metal will become more active. The Continental demand has improved of late, although it does not seem to be on such a good scale as in this country. A shipment of Continental spelter arrived in this country this week and further consignments are expected, so that it is probable that the present contango will be maintained.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/- rebate*)	3 7 6	—
Midlands—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/- rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/- rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow	
	4 0 6 „ Sheffield	
	4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

London and the South—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¾in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¾in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¾in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0 to 7 15 0	8 5 0
Boiler Plates, ¾in.	9 7 6	8 5 0

STEEL (*continued*).

Glasgow and District—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¾in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¾in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home.	Export.
	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 12/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·23% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/- per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/-
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/-
„ „ „ 1 p.c. carbon	£36 5 0	11/-
„ „ 0·70 p.c. carbon	£37 5 0	12/-
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/- p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/- to 5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, May 8th.

Copper—		
Cash	£32 12 6 to £32 13 9	
Three months	£33 0 0 to £33 1 3	
Electrolytic	£36 0 0 to £36 10 0	
Best Selected Ingots, d/d Birmingham	£36 5 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£28 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9d.	9d.
„ Brazed	11d.	11d.
Tin—		
Cash	£224 0 0 to £225 0 0	
Three months	£218 5 0 to £218 10 0	
Lead	£13 1 3 to £13 6 3	
Spelter	£14 0 0 to £14 5 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
f.o.b. Grangemouth—Navigation Unscreened	13/- to 13/6
„ Glasgow—Ell	15/6 to 16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/- to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/9 to 14/-
Unscreened Navigation	12/9 to 13/-
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	12/- to 12/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/- to 17/6
Northumberland, Newcastle—	
Blyth Best	13/9 to 14/-
„ Second	13/3
„ Best Small	10/6 to 11/-
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/6
Foundry Coke	19/- to 20/-

Sheffield—	Inland.
Best Hand-picked Branch	24/- to 26/-
South Yorkshire Best	21/- to 23/-
South Yorkshire Seconds	17/6 to 19/-
Rough Slacks	8/- to 9/-
Nutty Slacks	7/- to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/- to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/-
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/- to 26/-
Foundry Coke	24/- to 37/6
Furnace Coke	19/- to 21/6
Patent Fuel	21/-
Swansea—	
Anthracite Coals:	
Best Large	36/- to 40/-
Machine-made Cobbles	41/- to 48/6
Nuts	40/- to 48/6
Beans	25/- to 30/-
Peas	19/- to 22/6
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large	18/- to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0–950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Cartel.

THE three months' suspension of the 50 per cent. super import duty on foreign steel entering Great Britain has allowed of negotiations being resumed in Paris this week. The difficulties in the way of reaching a settlement are still very great. They were serious enough when foreign makers had a free entry into the British market, and the Cartel attempted to negotiate with British steel makers on the basis of a participation by Continental firms in the trade with the Dominions. In other words, the Dominions were to be grouped amongst foreign markets, and there is nothing to show that the Cartel has abandoned this claim, although it must be considerably weakened by the fear of being shut out altogether from the British market. On the Continent, it is really a struggle for existence, which is imposed by the dwindling consumption in producing countries. The threat of uncompromising competition with British steel in all foreign markets, in the event of the two parties failing to reach an agreement, is the consequence of Continental makers being driven to an extremity. That threat, however, is tempered by the recollection of the disastrous slump that occurred eleven or twelve years ago after the Cartel had broken down, and it is difficult to imagine that Continental makers will resort to a price war that may involve a repetition of that experience. An anomalous feature of the situation is that all members of the Steel Cartel keep their respective home markets to themselves, and their sole object is to obtain a fair participation in the foreign trade at official prices. If British steel makers join the Cartel they will be required to sacrifice a part of their own market, which they are apparently quite prepared to do on condition of their receiving equitable treatment in foreign markets. The difficulty lies in the industrial crisis, which reduces the Continental consumption to a point that compels steel makers to find foreign outlets at all cost, and it appears that the only logical solution at the moment is to reach some short-time agreement which will provide an adjustment of conflicting interests until it is possible to gauge the future with more certainty.

Railway Deficits.

The annual reports of the railway companies show no alleviation of the financial embarrassments that have been accumulating for five years past. The 4000 million francs deficit in 1934 was a repetition of previous annual losses, and since the beginning of the present year these stabilised losses are said to have started upon a further inflation. The country is confronted with the problem of what to do to save it from a burden that must inevitably fall upon the community unless the railway companies are allowed to carry on business normally, instead of running it under the dictatorship of the State. Following upon the withdrawal of the former State financial guarantee, the convention of 1921 accorded to the railway companies a fair measure of liberty in the management of the railways with a view to their becoming self-supporting, and all the profits were pooled in a common fund so that the losses of some companies could be made good by profits from others. The companies affirm that if the convention had been observed by the State the present difficulties would not have arisen. Their liberty was curtailed and practically suppressed by parliamentary interference and State decrees, which prevented the companies from adopting measures for adjusting receipts to expenditure. At the same time, the State taxation was heavily increased and additional burdens were imposed by the eight hours' working day, an advance in railwaymen's wages and new social charges. The State takes from the railway companies, in one form or another, more than 2600 million francs a year. The common fund has a deficit of 17,384 million francs, which have had to be advanced by the Treasury. A solution of this financial problem is urgent at a time when the companies are improving the efficiency of the railway system and adapting it to new traffic conditions, with the prospect of making railway enterprise profitable in collaboration with road traffic, and if the future is to be assured the State cannot afford to delay relieving the companies of burdens that would not be tolerated in any other industrial undertaking.

A New African Harbour.

On account of the absence of natural sites for the construction of harbours on the coasts of French West African possessions a great deal of ingenuity has to be exercised in carrying out such works where there is no depth of water near the shore and heavy swells and shifting sands offer difficulties in keeping harbours open. Dakar, in Senegal, and Pointe-Noire, which provides the only outlet from the French Congo, are noteworthy achievements, and now a port is to be constructed at Abidjan, in the Ivory Coast. One of the difficulties to be overcome is the necessity for constant dredging, and before completing plans for the Abidjan harbour the French authorities arranged with the hydraulic laboratory at Delft, in Holland, to carry out experiments in order to determine the effects of currents on models supplied.

Vegetable Oil Motor Fuels.

After the close of the International Colonial Exhibition in Paris in 1931 an attempt was made by Monsieur Charles Roux to make the journey from Paris to the Niger by way of the Sahara Desert with two motor cars fitted with engines adapted to run on oils distilled from vegetable products in the Colonies. The cars were abandoned in the desert. Six weeks ago Monsieur Roux started again with cars fitted this time with Bagnulo engines, an Italian design which has given satisfactory results with different kinds of oil fuels. Since the previous journey the route across the Sahara has been organised, and the caravan was able to reach the Niger after much trouble through sand storms and high temperatures. At Bamako Monsieur Roux will install a distillation plant and continue experiments with a view to demonstrating the practicability of running motor vehicles in French West Africa with locally produced vegetable oils.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

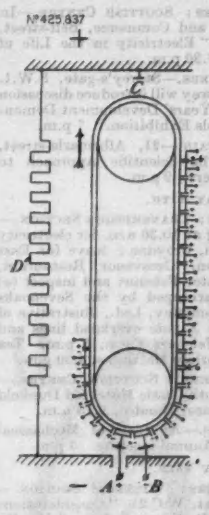
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

425,837. September 22nd, 1933.—THE PRODUCTION OF ELECTRIC UNIDIRECTIONAL HIGH POTENTIAL, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

A number of electric condensers connected in series are mounted on an insulated band stretched between two pulleys, one of which is driven. The condensers extend for approximately half the length of the band. Opposite one of the wheels there are two contact brushes A and B. A is connected with a source of unidirectional potential, while B is earthed. As the condensers pass the brushes, they are charged, each to the potential of the source, so that when the whole string has passed by there is a difference of potential between the two ends equal to the sum of the individual charges. The first condenser then meets the brush C, and the full voltage is available for use in any appropriate appliance, such as that indicated conventionally at D. Several variations are described in the specification. The following gives certain values which have been used in a practical arrangement:—Distance apart from the axes of the wheels, 10 m.; length of the carrying band, 22 m.; space occupied by each condenser, 1 cm.; number of condensers, 2200; capacity of the condensers, 0·1 microfarad; charging potential, 3000 volts; velocity of the band, 5 m. per second. With such an arrangement, using dual charging, a current of 0·3 milliampères at a potential of 3,000,000 volts, has been obtained.—*March 22nd*, 1935.

№425,837

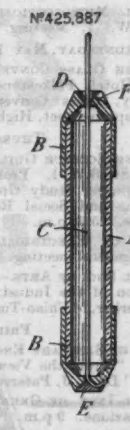


SWITCHGEAR.

425,887. December 3rd, 1934.—ELECTRIC FUSES, S. L. Lightfoot, The Standard Fuse Company, Queensway Works, Ponders End, Middlesex.

This invention relates to electric fuses of the kind wherein the fuse wire is soldered to metal terminals applied to the ends of a glass or like tube which houses the wire and forms a kind of cartridge for ready insertion into an electric circuit. In making fuses of this kind, a plurality of cartridges are threaded on a length of the wire, and solder is applied to the different terminals for sealing the wire to the latter. Finally, the cartridges are separated and finished by wrenching off the wire close to the terminals. In thus wrenching off of the wire, the seal is liable to be disturbed, in which case there will no longer be a proper electric connection between the wire and the terminals. The principal object of the invention is to ensure proper electric connection between fuse wire and terminals without complicating the sealing and separating operations, and consists in forming each terminal with a lateral nick into which the wire can be folded before the sealing, so that the wire ends can subsequently be wrenched off without subjecting the soft sealing metal to any strain. The cartridge comprises a glass, or like, tube A, the ends of which are closed by metal caps B forming terminals for an electric fuse wire C. The latter passes through apertures in the caps, which are formed with craters D for the reception of solder E by means of which the wire is sealed to the terminal. Each terminal is formed with a laterally disposed nick F into which the fuse wire can be folded as shown, before the crater D is filled in with the sealing metal E. After the fuse wire has been fixed in the nick in this manner, the external wire end can be wrenched off without disturbing the seal, and a faultless electric connection will thus be ensured.—*March 22nd*, 1935.

№425,887

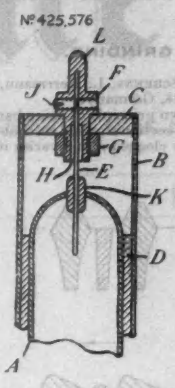


ELECTRICAL APPLIANCES.

425,576. July 25th, 1934.—ELECTRIC DISCHARGE TUBES, Quarzlampen-Gesellschaft mit beschränkter Haftung, Waldstrasse 28, Hanau, Germany.

This invention relates to electric discharge tubes, of which the ends or parts containing the electrodes are covered by caps, which are connected together. In discharge tubes of this kind it has been proposed to cement the ends in the caps or to secure them with bands or the like. When the tube is supported in this manner difficulties are encountered when the discharge tube becomes heated in operation to a temperature of several hundred degrees, as may occur, for example, in the case of high-pressure metal vapour lamps. According to this invention, in a discharge tube in which the ends or parts containing the electrodes are covered by caps which are rigidly connected together by means independent of the discharge tube, the caps are provided with means for clamping or holding the lead-in wires and the lead-in wires are held thereby, so as to support the tube. The invention comprises also a cap for attachment to the end of an electric discharge tube which is provided with means whereby the lead-in wire can be clamped or secured. In order to protect the sealed joint from heavy mechanical stresses, the length of wire between the sealed joint and the clamp is made relatively long. Preferably, this distance is at least five times the diameter of the wire. Referring to the drawing, the discharge tube A is provided at both ends with a metal cap B, which caps are rigidly connected together by means of a rail which is not illustrated and are closed at their ends by discs C, made of insulating material. The space between the discharge tube and the cap is filled with an asbestos filling D, so that the tube is guided thereby to a certain extent in the cap. The actual supporting of the tube is, however, effected by the lead-in wires E, which are securely screwed into the mounting, namely, into a clamp F. The clamp F is fixed to the insulating disc C by means of a nut G, and a recess H, the diameter of which is greater than is necessary in order to be able to introduce and hold the lead-in wire, is bored out. The lead-in wire E is clamped in the clamp F by means of a lateral grub screw J. The length of the lead-in wire between the seal K and the clamping place at J is at least five times as great as the diameter of the wire. Further, the clamp F has a pin L to which the current lead can be connected.—*March 18th*, 1935.

№425,576



TRANSMISSION OF POWER.

425,929. January 24th, 1934.—CHANGE-SPEED GEARING, C. R. H. Boun, 56, Gibson-street, Hillhead, Glasgow.

This gear-box contains a series of sun and planet gear trains driven by the driving shaft A. Any one of these gears can be put in action by sliding its internally toothed outer ring endways, so that its conical face B, for instance, engages with the conical casing and is consequently held fast. The sliding action is produced by hydraulic pressure admitted through the ports C C and controlled by the valve D. The cage gearing E provides a reverse drive for the driven shaft F, and also an additional forward drive.—*March 25th*, 1935.

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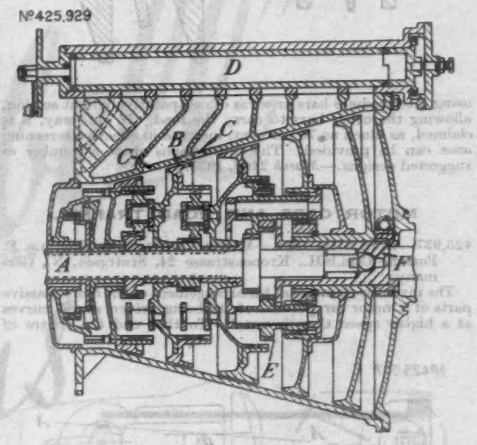

426,288. February 9th, 1934.—SPEED-GOVERNING DEVICES, Boulton and Paul, Ltd., Riverside Works, Norwich, J. D. North, Mill House, Eaton, Norwich, and A. Doe, St. Peters, Earlham Green-lane, Norwich.

This speed-controlling gear, it is suggested, is suitable for rotating the gun turrets of aircraft. The driving shaft from the motor is indicated at A. On its end there is splined a disc B. This disc carries weighted bell cranks C, the ends of which bear against the axially fixed disc D. If the speed of the motor increases the disc B is consequently pushed forward to engage the friction disc E, which is free to slide on the driven shaft F, but is splined thereto. Beyond the friction disc there is a brake disc G, which is supported by a parallel link motion, as shown in Fig. 2. This suspension system is connected by the linkage H with the spindle J of the motor throttle valve. It will be appreciated that the distance between the brake disc and the clutch plate will be dependent upon the angle through which the valve spindle has been turned from its neutral position, irrespective of whether the spindle has been turned to effect clockwise or counter-clockwise rotation of the driven shaft. If the speed of revolution of the driven shaft reaches a predetermined limit, the disc B on the driving shaft and clutch plate E on the driven shaft will be moved by the action of the governor weights C into contact with the brake disc G, thereby causing a diminution in speed of rotation of the motor. It will be clear therefore that for every setting of the throttle valve there will be a maximum speed—determined by the distance apart of the brake disc and clutch plate—beyond which the motor cannot go.—*April 1st*, 1935.

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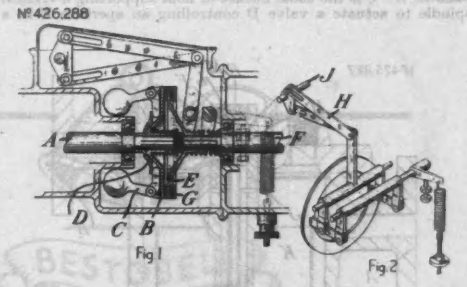


BUILDING.

425,581. October 4th, 1934.—THE PRODUCTION OF CONCRETE STRUCTURES, International Latex Processes, Ltd., 10, Lefebvre-street, St. Peter's Port, Guernsey, Channel Islands.

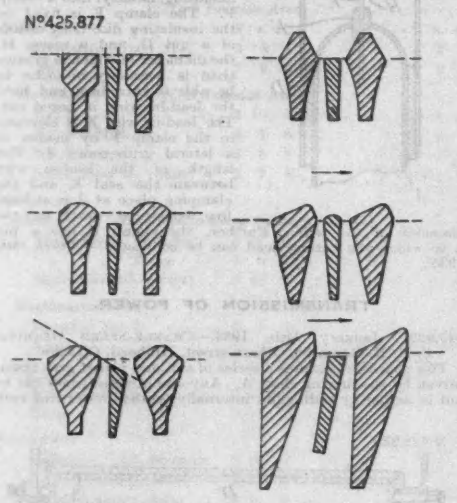
In order to protect the surface of structures made of Portland cement concrete from atmospheric evaporation, and thus ensure its proper curing, the inventors propose to cover it with an impervious layer of rubber latex emulsion. This emulsion is mixed with barytes, clay or talc, which sinks through the

emulsion, when it has been applied, and forms an inert layer that facilitates the subsequent stripping of the rubber coating. It is suggested that the coat should contain from 1 oz. to 3 oz. of rubber per square yard of surface to be treated.—*March 18th*, 1935.

CRUSHING AND GRINDING.

425,877. September 13th, 1934.—Screens, L. Herrmann, 33, Zwickauerstrasse, Dresden, A.24, Germany.

This screen employs the well-known principle of using bars or wires of vertically decreasing cross-sectional area, so that the intervening spaces may not become clogged; but varies it by

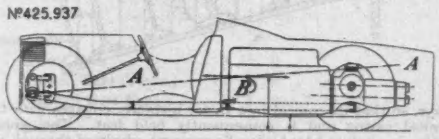


using intermediate bars or wires of comparatively light section, allowing the other bars to carry the load. In this way, it is claimed, as much as 70 per cent. increase in effective screening area can be provided. The illustrations show a number of suggested designs.—*March 22nd*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

425,937. April 27th, 1934.—Motor Vehicles, Dr.-Ing. h.c. F. Porsche G.m.b.H., Kronenstrasse 24, Stuttgart, N., Germany.

The inventor claims that his arrangement of the more massive parts of a motor car permits of its being driven round curves at a higher speed than is usual. To that end the centre of

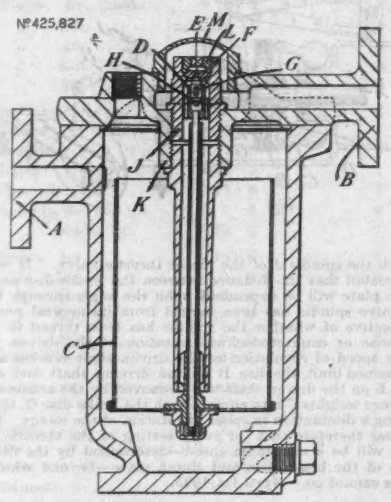


gravity of those masses is concentrated in a plane in which are also situated the points of attachment of the springs to their axles. In the drawing this plane is represented by the line A A, while the general centre of gravity is marked B. It will be noted that the engine, gear-box, and fuel tank are arranged behind the driver's seat.—*March 25th*, 1935.

MISCELLANEOUS.

425,827. November 22nd, 1934.—Steam Traps, C.M. and M. (1929), Ltd., H. S. Inman, and H. Speight, Prospect Works, Wakefield-road, Bradford, Yorkshire.

This invention relates to steam traps of the bucket or float type and has for its objects, primarily, to prolong the effective life of the valve mechanism, and, secondly, to enable any defect due to wear in the valve mechanism to be rectified with facility and with a minimum of expense. The trap has an inlet A and exhaust B. C is the usual bucket or float supporting a vertical spindle to actuate a valve D controlling an aperture E in a



circular valve seating F. The valve D is cylindrical in cross section and is formed with conical extremities, and transversely of the valve D there is an elongated slot through which there passes a gudgeon pin G, whereof the ends are supported in diametrically opposite apertures in a tubular guide H secured to the upper extremity of the float spindle, the valve D being a sliding fit within the guide H. The guide H is accommodated slidably within the bore of a housing J, whereof the lower extremity is screwed into a tubular neck K cast in one with the body of the trap. Near its upper end the housing J is formed internally with a flange or shoulder upon which the valve seating F rests, the valve seating being maintained in position by a plug L. In the event of the coned extremity of the valve D becoming grooved by contact with the seating F, the cap nut M and the housing J are unscrewed and the gudgeon pin G is withdrawn and the valve D is reversed to present the other conical extremity for contact with the seating F, after which the housing J and cap nut M are replaced. Similarly, if the lower edge of the orifice E in the seating F becomes worn they can be reversed.—*March 21st*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the time and place *at which the meeting is to be held should be clearly stated.*

To-day.

Inst. of Electrical Engineers: Scottish Centre.—In Hall of the School of Economics and Commerce, Bell-street, Dundee. The Faraday Lecture, "Electricity in the Life of To-day," Prof. E. W. Marchant. 7.30 p.m.

Inst. of Mechanical Engineers.—Storey's-gate, S.W.1. Informal meeting. Mr. John Holloway will introduce discussion on "Machine Tools: Twenty-five Years' Development Demonstrated at the Recent Machine Tools Exhibition." 7 p.m.

Royal Inst. of Great Britain.—21, Albemarle-street, Piccadilly, W.1. Discourse, "The Scientific Approach to Vocational Guidance," Dr. C. S. Myers. 9 p.m.

Saturday, May 11th.

Inst. of Electrical Engineers: Transmission Section.—Visits: Leave Institution Building at 10.30 a.m. for electricity works and the C.E.B. Sub-station, Croydon; leave for East Grinstead, 12.15 p.m.; luncheon, Grosvenor Restaurant, London-road, 1 p.m.; arrive Greater Felcourt and inspect (a) A special overhead-line exhibit arranged by the Sevenoaks and District Electricity Supply Company, Ltd., illustrative of that company's practice; (b) the X-pole overhead lines and electrical equipment at Greater Felcourt Farm, 3 p.m. Tea as the guests of Mr. and Mrs. R. Borlase Matthews, 4.30 p.m.

Inst. of Electrical Engineers: Scottish Centre.—Excursion from Dundee to Taymouth Castle Hotel *viâ* Dunkeld and Aberfeldy. Leave Albert-square, Dundee, 9.15 a.m.

Inst. of Highway Engineers.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Annual meeting. 3 p.m.

Monday, May 13th.

Inst. of Electrical Engineers: Wireless Section.—Savoy-place, Victoria Embankment, W.C.2. "Considerations in the Design of a High-Fidelity Radiogramophone," Mr. W. J. Brown. 5.30 for 6 p.m.

Tuesday, May 14th.

Inst. of Automobile Engineers: London Graduates.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. Films of engineering interest. 8 p.m.

Illuminating Engineering Soc.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Annual general meeting, 6.30 for 7 p.m. Address, "Production of Light," Professor Dr. M. Pirani, of Berlin. 7.15 p.m.

Wednesday, May 15th.

Inst. of Electrical Engineers: South Midland Centre.—Visit to Droitwich Broadcasting Station. 3 p.m.

Royal Meteorological Soc.—49, Cromwell-road, S.W.7. Meeting. 4.30 for 5 p.m.

Royal Microscopical Soc.—B.M.A. House, Tavistock-square, W.C.1. Meeting. 5 for 5.30 p.m.

Wednesday, May 15th, to Saturday, May 18th.

British Glass Convention, Folkestone.—Headquarters, Grand Hotel, Folkestone. Full particulars from the Hon. Secretary, Glass Convention Offices, Norwich House, 13, Southampton-street, High Holborn, W.C.1.

Thursday, May 16th.

British Science Guild.—At Inst. of Civil Engineers, Great George St. S.W. 1. Presentation of First Interim Report of the Engineers Study Group on Schemes and Proposals for Economic and Social Reforms. Speaker. Lieut-Col. J. V. Delahaye. 5.30 p.m.

Inst. of Electrical Engineers.—Savoy-place, W.C.2. Annual general meeting. 5.30 for 6 p.m.

Royal Soc. of Arts.—John-street, Adelphi, W.C.2. "The Evolution of the Industrial System in the Far East," Prof. A. F. Barker, of Chiao-Tung University, Shanghai. 8 p.m.

Friday, May 17th.

Inst. of Sanitary Engineers.—Caxton Hall, Westminster, S.W.1. "From the View Point of a Rural Medical Officer of Health," Dr. J. J. Paterson. 6 p.m.

Royal Inst. of Great Britain.—Burlington House, W.1. Conversazione. 9 p.m.

Monday to Friday, May 20th to 31st.

British Industries Fair: Engineering and Hardware Sections.—Castle Bromwich, Birmingham. Daily except Sunday.

Tuesday, May, 21st.

Inst. of Fuel.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "The History and Construction of the Iraq Pipe Line," Sir John Cadman. 6 p.m.

Inst. of Mechanical Engineers.—Visit to British Industries Fair, Castle Bromwich.

Manchester Assoc. of Engineers.—Visit to the works of the Lancashire Steel Corporation, Ltd., Irlam. 2.30 p.m.

Wednesday, May 22nd.

Inst. of Electrical Engineers: South Midland Centre.—Visit to Droitwich Broadcasting Station. 3 p.m.

Friday, May 24th.

Royal Inst. of Great Britain.—21, Albemarle-street, W.1. Discourse by Mr. S. C. Roberts. 9 p.m.

LAUNCHES AND TRIAL TRIPS.

Cragside, steamship; built by the Furness Shipbuilding Company, Ltd., to the order of the Tyne-Tees Steam Shipping company, Ltd.; dimensions, 160ft. by 27ft. 6in. by 12ft.; to carry fabricated steel materials. Engines, triple expansion, 12in. by 20in. by 33in. diameter by stroke of 24in.; pressure, 200 lb. per square inch; constructed by the North-Eastern Marine Engineering Company, Ltd.; launch, April 30th.

Moira, all-electric welded steamship; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Marna Company, of Oslo; dimensions, 245ft. by 42ft. 2in.; to carry oil in bulk. Engines, reciprocating engine working in conjunction with low-pressure turbine on Bauer-Wach system; constructed by the builders. Launch, Tuesday, April 30th.

Hopecrest, single-screw motorship; built by Barclay, Curle and Co., Ltd., to the order of the Hopemount Shipping Company, Ltd., Newcastle-upon-Tyne; dimensions, 410ft. by 57ft. 3in. by 38ft.; to carry cargo. Oil engine, of Barclay, Curle-Doxford type, 600 mm. diameter by 2,320 mm. combined stroke; constructed by the builders; trial trip, May 1st.

City of Manchester, twin-screw cargo steamer; built by Cammell, Laird and Co., Ltd., to the order of the Ellerman Lines, Ltd.; dimensions, 485ft. by 64ft. by 33ft. 9in.; to carry cargo. Engines, turbines of Parsons' type; pressure, 275 lb. per square inch; launch, May 2nd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Holloway Brothers (London), Ltd., have appointed Mr. W. Storey Wilson, B.Sc., M. Inst. C.E., a director of the company, in place of the late Mr. G. F. Palmer, M. Inst. C.E.

Mr. Roland Dunkerley has resigned his position as comptroller of the United Steel Companies, Ltd., Sheffield, to take up the position of director and general manager of Quilt Manufacturers, Ltd., Manchester, a Lancashire textile combine specialising in the manufacture and distribution of quilts, towels, and similar goods.

Mr. M. M. Gillespie, M.I.E.E., of Gillespie and Beales, Norfolk-street, Strand, London, W.C.2, has recently been appointed to the board of J. Browett-Lindley (1931), Ltd., engine and compressor manufacturers, Letchworth, Herts. For many years Mr. Gillespie was a director of Browett Lindley and Co., when the factory was situated at Patricroft, Manchester, and was closely associated with the development of gas and oil engines and gas and air compressors.

Thos. W. Ward, Ltd., of Sheffield, has acquired Palmers, Jarrow Shipyard from National Shipbuilders' Security, Ltd., on dismantling terms. Part of the shipyard may be used by the firm for ship-breaking, thus providing employment for some of the workpeople in the district. The hopes of restarting the blast-furnaces and steel works of the Palmers Company at Jarrow, which adjoin the shipyard and which were also acquired some time ago by Messrs. Ward from the receiver, seem likely to be realised, as negotiations with this end in view are now in an advanced stage, and these or other industries may eventually require the shipyard site.

George Kent, Ltd., of Luton and London, announces that an agreement, applying only to the sale of industrial electro-chemical instruments and certain types of flow meters, has been made between the firm and the Leeds and Northrup Company of the United States. Under this agreement the Leeds and Northrup Company will not offer its industrial electro-chemical instruments or its flow meters for sale in the British Empire (except Canada) unless through Messrs. Kent, while Messrs. Kent will not offer their similar instruments in the United States or Canada unless through the Leeds and Northrup Company. The sale anywhere by either company or its agents of products other than those specifically mentioned above, is not in any way affected by this agreement.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

Morris Motors, Ltd., has received from Wallis and Steevens, of Basingstoke, another order for industrial engines for 2½-ton road rollers.

The British Thomson-Houston Company, Ltd., has secured from the General Post Office, Stores Department, a contract for the supply of Mazda lamps during the next twelve months.

The Hunslet Engine Company, Ltd., Leeds, 10, has received an order from the Peruvian Corporation for the Trujillo Railway for one "Consolidation" type locomotive having eight wheels coupled with leading truck and double-bogie tender, fitted with superheater and arranged for coal burning; gauge, 3ft.; cylinders, 18½in. by 24in.

"World Survey."—*World Survey*, published under the auspices of the World Power Conference, is the title of a new monthly magazine. Its objectives are to present and analyse world economic trends and to publish essential economic information. At the same time, it is intended to deal with all major aspects of economic activity and to record by means of special index numbers changes in production and trade, prices, and stocks, &c., throughout the world. Believing that in economic affairs national limits too frequently obscure a correct understanding, and that a world analysis is the appropriate way of approach, its articles and comments aim at elucidating the universal aspect. The first number appeared in April.

Baldwins, Ltd.—Most well-known firms have at some time published a brochure describing their works and products, and we have recently had the pleasure of receiving from Baldwins, Ltd., a book entitled "British Coal, Iron, and Steel," giving a survey of the firm's constitution, products, &c. Full of interesting matter it contains over 100 pages, and is divided into five main sections. Opening with a brief history of the firm, chapters follow on Coal, Iron, the Transmutation from Iron to Steel, and Steel in Modern Life. Lists are given of the company's directors; properties belonging to it and those belonging to subsidiary and allied companies; manufactures and annual capacities; and branches and their products. There are also various useful tables. The book has been plentifully illustrated with photographs by Mr. P. G. Hopcroft, F.R.P.S., who has shown that even the processes and materials of steel production can form excellent photographic studies for an expert with the camera.

University Scholarships.—The Manchester Education Committee offers a limited number of scholarships and exhibitions, tenable in any one of the three years' full-time day courses leading to the degree of Bachelor of Technical Science (B.Sc. Tech.) at the Municipal College of Technology (Faculty of Technology in the University of Manchester). Candidates for scholarships must have passed, or hold exemption from, the matriculation examination of the Joint Matriculation Board of the Northern Universities and must also be qualified to enter upon a higher course. The scholarships will be open to part-time day or evening students in the College and others whose parents are ratepayers of the city. In the event of there not being sufficient Manchester students qualified to enter upon a higher course, and only in that case, the Committee may offer the scholarships to suitably qualified students who have no ratepayer qualification. Candidates for exhibitions must have passed, or hold exemption from, the matriculation examination of the Joint Matriculation Board of the Northern Universities and be qualified to enter upon an ordinary course. Candidates for these exhibitions must be ratepayers, or children or wards of ratepayers of the city of Manchester. Forms of application and all information may be obtained by written application to the Registrar, College of Technology, Manchester, 1. Completed forms of application must be received on or before June 20th, 1935.